THE ELECTRICAL WORLD
AN ILLUSTRATED WEEKLY REVIEW of CURRENT Progress IN Electricity AND ITS PRACTICAL APPLICATIONS

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His Honor Investigates.

A REPORT is current that Mayor Grant, who has so often displayed his keen interest in matters electrical, is going to devote a little of his exceedingly valuable official time to an excursion to Boston for the purpose of investigating the overhead trolley system, which he has recently learned is in use in that redoubtable centre of civilization. We shall be glad if this report concerning his Honor, the Mayor, turns out to be true, for in the first place it will relieve the city for a few days from the probability of any more subway machinations, and in the second place if his Honor stays in Boston long enough he may acquire a few ideas concerning electric traction that will be of service to him. The deadly overhead wire on the whole has worked very satisfactorily in Boston, and although it may offend the æsthetic sense of the cultured chief executive of this city, he will have some difficulty in collecting any extensive series of disasters with which to regale his favored constituents. He might also find pleasure and profit in a visit to Philadelphia where the storage battery and trolley interests are engaged in a friendly skirmish after the fashion of the celebrated one indulged in by the Kilkenny cats; and if his Honor still remains unsettled, as is quite possible after this mass of conflicting testimony, we would respectfully recommend him to visit Chicago and spend a few days in attempting to secure a continuous ride over the North Side cable line in that city. After his return he will be in a proper frame of mind to undertake the consideration of the rapid transit problem in New York without an extraordinary bias in any one direction, except possibly towards Hugh J. Grant.

The London Electric Underground.

THE first fortnight in the history of the operation of the City & South London Railway has been on the whole a very gratifying one. The number of passengers carried has been satisfactory, and the system has operated smoothly without any breakdowns to cause public criticism. Seventeen thousand passengers per day, however, ought to be very far from the ultimate traffic over the line, and presumably an increased number of trains and a gradual setting of the great tide of public travel in that direction will make the present record look very small a year hence. In the present agitation concerning underground transit in New York news of the general success reached in London ought to serve as a stimulus to hasten the adoption of a similar plan here. It might be somewhat more difficult to construct the tunnels here than in London, but it is very safe to say that the number of passengers carried would be enormously greater than any one London road could hope for, for the good reason that the movement of the traveling public in New York is in a single direction, and any road along that direction would get its full share. Those interested in rapid transit could not do better than to pay a brief visit to London and investigate the conditions of working and the general methods employed in the City & South London Railway.

Electrical Units.

WE take pleasure in publishing this week the first portion of a clear and exact account of modern electrical units, by Prof. A. L. Kimball, of Johns Hopkins University. In spite of the constant use of these fundamental electrical quantities and their everyday familiarity to electricians, an exact knowledge of their character and all-important mutual relations is by no means as common as it should be. For this reason we would specially commend Professor Kimball's paper to our readers as discussing this somewhat complicated subject in a singularly simple and accurate manner. Starting with the familiar units of length, mass and time, he develops one by one the absolute and practical electrical units. And it is worth while noticing in this connection that the absolute unit of to-day may serve to found the practical unit to-morrow. For example, the watt, derived strictly according to the principles of the C. G. S. system, may very probably, by its multiple. the kilowatt, replace the horse power. This would be an advantage in every way, for not only would it avoid the inconvenient factor 746, but would prevent confusion between the English horse power of 746 watts and the French *cheval-á-vapeur* of 735 watts. In course of the systematic treatment of the subject Professor Kimball carefully develops the dimensions of the derived units with reference to length, mass and time. These dimensions may often serve as touchstones to test the exactness of physical equations and lead to the detection of incorrect results. Another thing that is admirably brought out is the relation of the practical electromagnetic units in everyday use to the corresponding absolute ones used in scientific measurements and necessary in the adaptation of theoretical formulæ to practical ends. We cannot do better for our readers than to commend this paper of Professor Kimball to their careful study as containing facts that should be part of the equipment of every electrician and here set forth with a distinctness and completeness that is rarely equalled in a popular article or even a scientific treatise.

Electricity and Fires.

THERE seems to be a popular mania for ascribing the origin of fires to electricity whenever by the wildest flights of the imagination such a conclusion might be reached. A famous case of this sort is that of the great fire in Boston a little over a year ago. There was absolutely no evidence to connect its origin with the electric wires, although a vigorous effort was made to secure such. The flames left no trace of their origin behind them, and yet that fire is being used to-day by opponents of electric lighting and power as a case of disaster due to the crossing of electric wires. There is not, and there never has been, a particle of evidence to show that such was the case, other than the fact that the building in which the fire occurred had electric wires in it. There is something akin to malice in these attempts to saddle upon the electric current every fire of unknown origin. In the case of the recent one in the Gilsey block in this city the papers, some of them at least, ascribed its cause to the electric light wires, not even stopping to investigate the evidence. As a matter of fact there is very good evidence that electricity was quite blameless in the matter, and yet we presume that this fire will be used by the opponents of electric lighting as an awful example for the next four or five years. Of course on general principles a lie always spreads at least twice as fast as the truth, so that when a rumor of this kind is once started the contradiction never catches up with it. It is a significant fact that some of the gas companies make a regular practice of accumulating all these rumors of damage from electric wires and no small amount of the activity that has been displayed in disseminating these false reports may come from business rivalry of a very obvious kind. The lack of imagination in the average human being is admirably displayed by the present state of things. Spontaneous combustion has quite gone out of fashion, the cigar stub lies smoldering neglected in its rubbish heap, rats are no longer suspected of tampering with matches; but whenever and wherever a fire occurs the natural tendency of mankind seems to be to follow the present fad of charging it to crossing wires.

The Henry Motor Truck.

WE illustrate on another page a new street car motor and truck designed by one of the very earliest experimenters with electric traction, and embodying the results of some years of experience. The new truck possesses some striking qualities; in the first place, no attempt whatever is made to arrange for a spring support of the motor, which is fastened rigidly to a solid frame that carries the car wheels. Only one pair of wheels is driven directly, and it drives the other pair by connecting rods, as in a locomotive. Only one motor is employed, and this is very solidly constructed and wound with very coarse and heavily insulated wire. The armature is a Gramme ring of many sections and very low resistance. All this is good, and in addition Mr. Henry has endeavored to secure another advantage in so arranging the armature that it may run constantly, or be started in advance of the movement of the car, and may take up its load gradually through the action of a clutch. This principle of starting a motor so as to take advantage of the armature momentum in moving the car is one which has recently become a favorite with inventors, although it is by no means new, since Mr. Henry tried it some years ago. A single motor flexibly connected to its rod; a Gramme armature of large diameter geared down but once, and that gear running in oil—all these are features that commend themselves at once. The points to which we should look for the results of practical experience are the action of the clutch that controls the epicyclic gear, and the practical result of supporting the motor rigidly instead of flexibly. Of the efficacy of the former arrangement we can only learn through extensive trials. It has been tried several times without success; but it involves by no means an insoluble mechanical problem, and we hope that Mr. Henry has successfully avoided some of the earlier difficulties. Of the latter point, we can only say that, with a good track, a rigidly supported motor is not objectionable, just as our English cousins find that a rigidly supported locomotive operates with perfect success when the roadbed is properly built. The present motor and truck have been designed for actual use on a considerable system of roads, and we trust that their practical operation will put at rest all questions that may arise concerning the merits of the mechanical arrangement. The electrical features of the motor are evidently a long step in the right direction.

Electric Companies.

THE public is gradually awakening to the fact that some very excellent investments may be had in divers electrical industries Our financial columns furnish sufficient evidence of this fact, and yet it seems to us that there should be spoken a word of warning, not so much directed toward intending investors as to those who are organizing electrical companies. There is at present a most reprehensible tendency to over-capitalize. Of course the enthusiastic inventor dreams of millions that will be secured in a few years by the vast industry that he is going to create, but he would do well before committing his enterprise to a legal incorporation to get competent advice from those who have already had some experience in exploiting electrical inventions. The loose incorporation laws in very many States, as, for example, Maine and Illinois, afford altogether too easy a means for fictitious capitalization. Companies are continually springing up with a nominal stock of anywhere from two hundred thousand to four or five millions of dollars based on patents that if properly worked might yield a satisfactory return on $25,000. On the more imposing basis the promoters are gratified with large blocks of stock that have not even a fictitious value, and honest investors are deluded into the idea that they are being let in on the ground floor, when in reality there would not be a reasonable prospect of fair returns at a quarter of the price they have paid. It is this tendency to exaggerate the possibilities of profit that has made electrical stocks difficult to float. People are gradually learning wisdom from experience, and to-day it is much easier to secure capital for a legitimate electrical enterprise than it has been in the past. Nevertheless we wish to utter this word of warning to those interested in the formation of electrical companies. Don't over-capitalize. Do not attempt to make a working capital of $10,000 bear the burden of a quarter of a million in stock. Organize an electrical corporation on a straightforward business-like basis, and conduct its operations accordingly. Organize it where you intend to operate instead of hunting about for a State where no paid-up capital is required. Do not try to make 10 per cent. of the alleged capital do all the work. And remember that in every sort of business honesty is the best policy. Corporations that sell stock instead of merchandise are always looked upon with suspicion and are likely to come to a bad end.

Latest Foreign Electrical News.

(By Cable from Our Regular Correspondent.)

LONDON, Jan. 12.—The traffic on the City & South London Railway during the first two months of its running has been very satisfactory. In the aggregate nearly a quarter of a million passengers have been carried during that period, bringing the daily average up very nearly to 17,000.

The Central Station at Deptford will not recommence running until February. The apparatus is being duplicated so as to avoid any recurrence of breakdowns, which have proved so exasperating.

A new method of rapidly and cheaply eliminating arsenic from copper, on the general principle of the basic process, has appeared, and may become of importance for electrical purposes. It was invented by Mr. Percy Gilchrist, and the first reports from it are decidedly favorable.

Municipal lighting is on the increase just now. The latest municipality to engage in it is that of Cambridge, where £35,000 will be expended on a central station.

A report comes from France that MM. Paul Hoho and Le Grand have perfected a system of electric welding differing radically from the Thomson process.

The first fruits of the expiration of the Bell telephone patents have appeared in the Mutual Telephone Company, which will commence active competition with the National Telephone Company next month; it will employ complete metallic circuits and push its work vigorously.

The title of the presidential address of Prof. Wm. Crookes before the Institution of Electrical Engineers on Feb. 15, will be: "Electricity in Transitu from Plenum to Vacuum."

ELECTRICAL WORLD PORTRAITS.—XXI.

PROF. J. A. EWING, F. R. S.

The subject of this sketch is to-day the most prominent authority on the all-important science of magnetism, and has added a vast amount to our knowledge of that occult subject, particularly its more recent developments. He was born in 1855, and received his early education at the high school in Dundee, after which he entered the University of Edinburgh, then the Mecca of students in engineering, owing to the distinguished works of Prof. Fleeming Jenkin and Prof. Tait. He gained there the Baxter scholarship in engineering and first medals and prizes in that subject, and was graduated B. Sc.

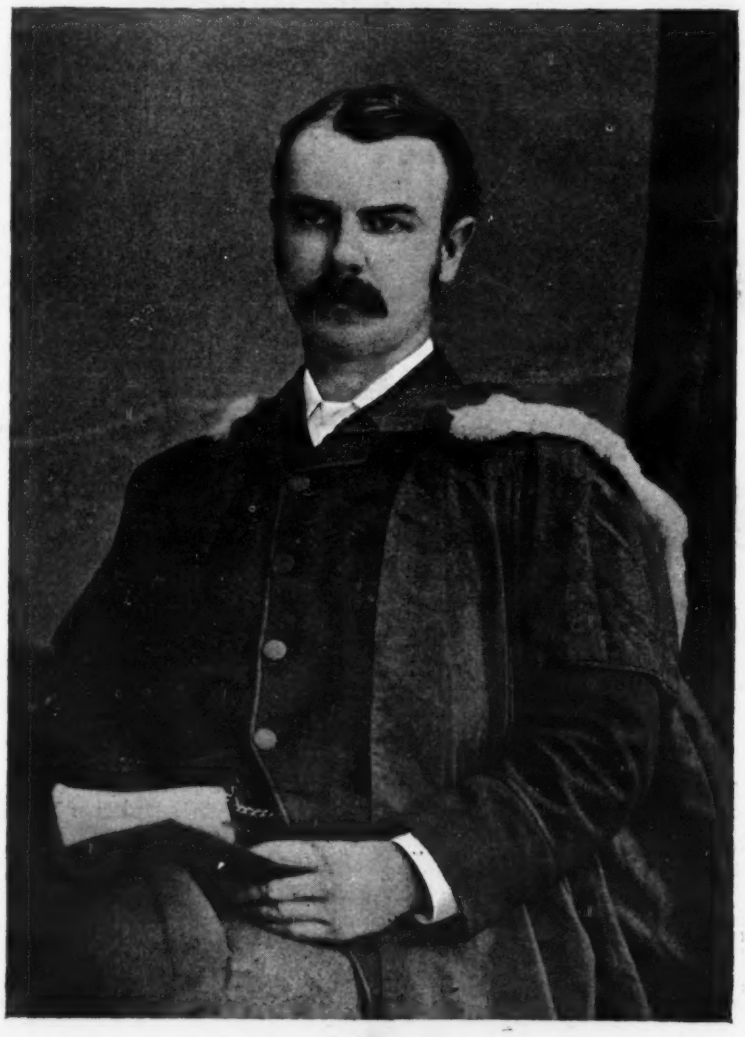
Shortly after his graduation he was asked by Prof. Jenkin to become one of Sir William Thomson's assistants in supervising the manufacture and laying of the Great Western Company's telegraph cables. In this work of submarine telegraphy he was engaged for several years, and in its course he visited South America three times with cable expeditions, and during the latter part of the period superintended the cable testing department of the company, and became thoroughly acquainted with the details of electrical testing in the cable factories, at that time the best and almost the only electrical laboratories. He was constantly associated with Sir William Thomson in cable work, and assisted him in various researches. After four years of the service he was associated for two years with Prof. Jenkin as his general engineering assistant, and throughout this period was engaged in most of the researches of that distinguished engineer. Among other things he assisted in an elaborate research on "The Constitution of Vowel Sounds" inspired by the then new phonograph. The results of this important work were communicated to the Royal Society in 1878. In that year he began his independent academic career as professor of mechanical engineering in the University of Tokio, a post which he held with distinguished honor for five years.

During his work in Japan he was called upon to give supplementary advanced lectures to the students in physics and to direct the laboratory work in that department. While engaged in this work Prof. Ewing's energies were directed to the investigation of magnetism, a subject which he has never since left. His first long paper, "Experimental Researches in Magnetism," communicated to the Royal Society after his return to England, was a result of his researches in Japan accomplished with the assistance of Japanese students. It was also while in Japan that he elaborated another paper on "Hysteresis in the Magnetization of Iron." The word "hysteresis" is Prof. Ewing's own, and was coined for the express purpose of designating phenomena hitherto unknown or unrecognized. Sir William Thomson, to whom this paper was confided for communication to the Royal Society, cut out the new word and substituted for it the phrase "effects of retentiveness;" in spite of this "hysteresis" filled a long felt want and is now familiar to every electrical investigator.

In 1882 Prof. Ewing was called back to England to become professor of engineering in the new University College of Electrical Engineering in Dundee. There he found ample provision for his work in an excellent electrical laboratory, and continued his magnetic researches. A most valuable series of papers from his pen appeared from time to time in the philosophical transactions in the proceedings of the Royal Society. Of late years Prof. Ewing's services have been somewhat in request as an electrical expert and consulting engineer; and he has contributed to the Encyclopædia Britannica some of the important electrical articles. His most recent, and we may say most valuable, work on magnetism is the paper on the "Contributions to the Molecular Theory of Induced Magnetism," communicated to the Royal Society in June of last year. It appeared before the British Association at its last meeting and was received with the greatest enthusiasm as by all odds the most important contribution of recent years to magnetic theory. Aside from this an important series of papers now appearing in the London *Electrician*, on "Magnetism in Iron and Other Metals," furnish a valuable résumé of the present state of the subject, no small part of which is due to Prof. Ewing's own indefatigable investigations.

It may be interesting to note that Prof. Ewing married, in 1879, an American lady, the daughter of the late Thomas B. Washington, of West Virginia. In 1887 he was elected a Fellow of the Royal Society, and is besides a member of the Council of the Royal Society of Edinburgh, and a member of other learned bodies.

The annexed list of some of Prof. Ewing's more important papers will show the immense activity that has been so marked a characteristic of his career. The titles of some of his papers are: "On Friction between Surfaces Moving at Slow Speed" (with Prof. Jenkin), "On the Harmonic Analysis of Vowel Sounds" (with Prof. Jenkin), "On Certain Effects of Stress in Soft Iron,"



PROF. J. A. EWING, F.R.S.

"Sanitary Reform in Japan," "On a New Seismograph," "Effects of Stress on the Thermoelectric Quality of Metals," "Effects of Retentiveness in the Magnetization of Iron and Steel," "Earthquake Measurement," "A New Form of Pendulum Seismograph," "On the Production of Transient Electric Currents," "On the Magnetic Susceptibility of Iron and Steel," "Experimental Researches in Magnetism," "On a new Form of Friction Gear for High Speeds," "Effects of Stress and Magnetization on the Thermoelectric Quality of Iron, "On the Magnetization of Iron in Strong Fields" (with W. Low), "On Manganese Steel" (with W. Low), "On the Influence of a Plane of Transverse Section on the Magnetic Permeability of an Iron Bar" (with W. Low), "Magnetic Qualities of Nickel" (with G. C. Cowan), "Seismometric Measurements of the Vibration of the Tay Bridge," "Earthquakes and How to Measure Them," "On the Magnetization of Iron and Other Magnetic Metals in Very Strong Fields" (with W. Low)," "On Time Lag in the Magnetization of Iron," and the following articles in the Encyclopædia Britannica: Seismometer; Sewerage; Steam Engines and other Heat Engines; Strength of Materials; Traction, Electric; Ventilation. Also the following in Chambers' Encyclopædia (New Edition): Dynamo; Electric Light; Electric Railway; Gas Engine.

Still a young man, Professor Ewing's contributions to the scientific knowledge of magnetism are inestimable, and we may confidently look forward to further splendid work in clearing up one by one the mysteries that hav surrounded this occult branch of science.

Electric Railways in Lincoln, Neb.

In reviewing the present condition and prospects of Lincoln's street railways under the suggestive caption "The Car Mule is Obsolete" the *State Journal* of Lincoln says that all lines outside of the paved districts are to be rebuilt in the spring, new material being used throughout. The rails will be of 45-pound steel and wherever necessary the tracks will be double. Extensions will be made to any part of the city or suburbs that promise to give enough traffic to justify the outlay. When the electric current is first turned on, it is hoped to have 30 miles of road in operation. It is the intention of the management to make it possible for every man in the city of Lincoln who desires to ride on the cars of this company to do so without walking an unreasonable distance to reach a line. They expect the city to grow, and announce their intention of keeping up with it. They do not doubt that in five years the system will require double the mileage and equipment with which the start in electrical service is made.

The power house for the entire system is located on K and Eighth streets. This building is fast approaching completion. The dimensions are 90 × 150 feet. At the outset it will be equipped with 350 h. p. steel safety boilers, four 125 h. p. automatic compound engines and four 125 h. p. generators. The machinery is so arranged that the capacity can be easily doubled. The equipment will consist of at least thirty and perhaps forty motor cars, sixteen and eighteen feet long and provided with 30 h. p. motors. The first order will be for 50 trail cars. All will be finished inside in polished hard woods, will have upholstered seats, and will be warmed and ventilated. Every night each car will be run into the central station, thoroughly inspected and cleaned, put into the storage house, and be in readiness to come out for service in the morning as fresh as a new car. This storage house will cover one quarter of a block of ground. In connection with the central plant there will be machine, carpenter and paint shops equipped for making all necessary repairs and building new cars from the ground up. The first equipment of cars will be purchased from eastern factories, but the additional rolling stock will probably be manufactured in Lincoln.

Electric Lights in the Hofburg.

For the last day or two, says the Vienna correspondent of the London *Standard*, the time-honored Hofburg has been, after dusk, one great illumination, the windows looking over the Burgplatz and the Franzensplatz, or the inner square of the Hofburg, being a blaze of light. The explanation is that experiments have been made with the electric light, which is to be installed throughout the palace. For the present only fifty-two halls, reception rooms and apartments have the new illuminant, but next spring it will be extended to the remaining forty-one rooms now occupied by the Emperor, the Empress, and the Archduchess Stephanie, and which are, therefore, not ready for the workmen.

The incandescent system is the only one adopted, and the chief difficulty experienced in fixing it arose from the strict orders against any alteration of the character and outward appearance of the handsome candelabra in embossed gold and crystal, which date from the time of the Emperor Francis I. In the great Ceremoniensaal alone there are twenty-seven of these, with fifty-four lights apiece. The difficulty was surmounted by inserting small white lacquered wooden tubes, resembling candles at a distance, into the old lusters, each tube being fitted with a movable lamp. The entire installation, when completed, will consist of 5,250 incandescent lamps, equal to 30,000 wax candles, in the apartments, and nearly 1,800 lights in the entrance halls, galleries and staircases, or some 7,000 lamps in all. This will be the largest installation in any one building in Europe. The length of the wires inside the building will be 15 English miles.

The experiments made at two different times were completely successful, and it was interesting to notice how well the magnificent ceilings were brought out, and what an unsuspected wealth of color was developed in the famous Flemish tapestries on the walls of the Privy Council Chamber and other apartments.

Electric Street Railways of Minneapolis, Minn.

The Minneapolis Street Railway Company, of which Mr. Thos. Lowry is president, is in a prosperous condition. During the past year, according to the Minneapolis *Journal*, some 80 miles of road have been entirely rebuilt. By July 4, 1891, the company hopes to be able to celebrate its great industrial achievement of changing the entire bed, tracks and equipment of all its lines from adaptation to horse power traction to the latest and best electrical power ap-

pliances. Both the Sprague and the Thomson-Houston electric system are in use. Centre poles are used to support trolley wires overhead, which carry the electrical current, as in other cities, but besides there are laid many miles of conduit for feed wires.

The present equipment of cars is 450, with 120 motors, costing each from $3,500 to $4,000. With the system completed, 200 or more will be needed. Several large power houses have been built, where are located 3,000 h. p. engines and 12 dynamos of 200 h. p. each. Employment has been given to some 1,500 men, nearly all being employed who made application, at fair wages.

The Henry Electric Motor Truck.

Quite a radical departure from the usual forms of motor truck and motor gearing is that shown in the accompanying cuts. It is due to Mr. J. C. Henry, who is well known as one of the earliest workers in electrical traction. Mr. Henry took out some of the first patents on the subject and has steadily followed up the progress of the art until the present. The new truck that we illustrate was designed by him for the use of an important street car syndicate on numerous lines controlled by it. The experiments which have led to this development have been very elaborate and the trials have for the most part, taken place at Rochester, N. Y., and Alliance, O., where the motors were built.

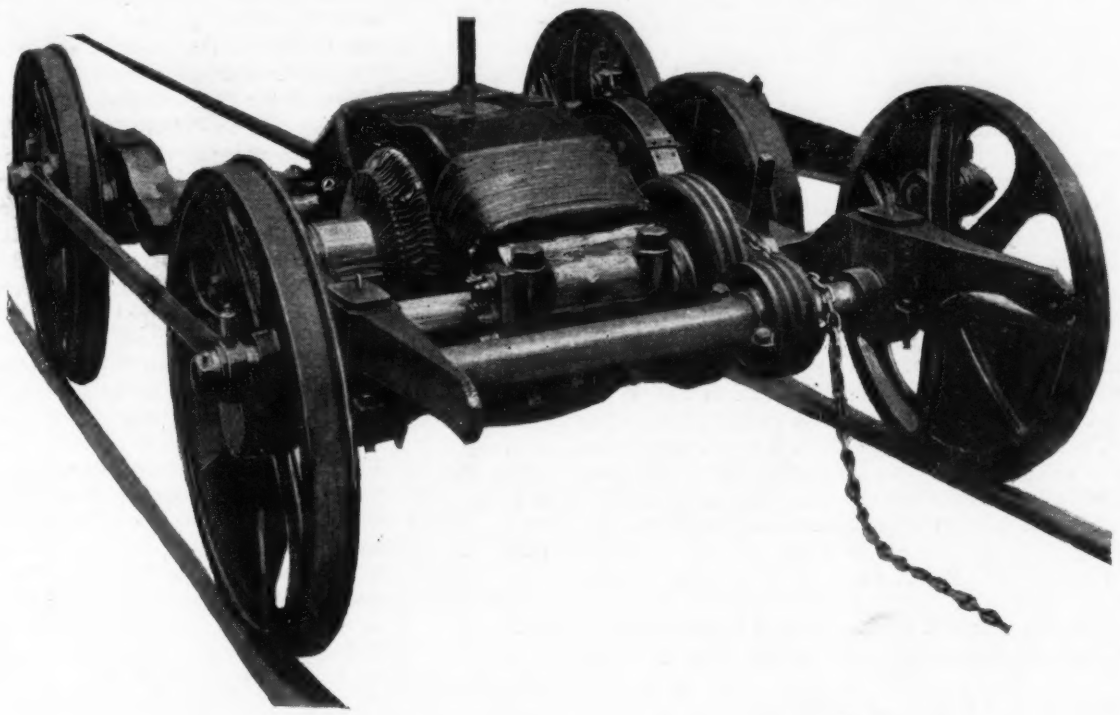


FIG. 1.—THE HENRY ELECTRIC RAILWAY MOTOR AND TRUCK.

The evolution in street car motor design has steadily been in the direction of simplifying the gearing and so winding the commutator as to secure it against the danger of burning out, which has been so serious. Nearly all our present forms of street car motors are centered upon the axle and are free to move through a small arc about its centre. Mr. Henry, however, for simplicity and strength of construction, has abandoned this method of procedure, and has followed out a design which reminds one forcibly of the English locomotive designs; in fact, the mechanical difference between this new motor truck and most of those already known to us is that between the English and American locomotives. The latter, as is well known to all of us, was designed for as great a degree of flexibility as the conditions of the problem allow, supported on springs at every point practicable.

The English designers on the other hand rely on the perfection of the track for freedom from shocks, and make the frame work of the machine as strong and simple as possible. As might be expected the results of the two types are equally good under the two conditions for which they are severally intended.

In the Henry motor and truck all spring supports are deliberately avoided, and an attempt is made to reduce the working parts to the smallest number possible, and to support them so firmly that there will be no danger of their getting out of order. The form of motor adopted is worthy of special notice as possessing some very meritorious features.

In the first place only one motor is employed, instead of two, and only one pair of wheels is driven by the gearing, the other being operated by a connecting rod. This construction, which might be objectionable on an old horse car track full of inequalities and continually getting out of line, is excellent when used in connection with proper track construction. The motor itself is rigidly fastened to the steel frame that connects the axles, its ends having bearings on three-inch steel axes, parallel with the axles of the wheels. The magnetic circuit has but two joints, and its form is not dissimilar to that which has been employed by Reckenzaun in England. It is very short and the windings are very compact; it has two consequent poles that embrace a Gramme armature 18 inches in diameter.

Of the peculiar fitness of the Gramme armature for traction purposes it is unnecessary to say much, for every electrician knows that this construction is highly desirable where high electromotive forces are to be used, for the reason that the danger of a short circuit is very much lessened. The armature is wound with two layers of No. 7 wire divided into 72 armature segments, each connected to its appropriate commutator bar. The winding is continuous throughout, loops being taken out at the commutator instead of the wire being cut. The face of the armature is 13 inches wide, and the clearance space is as small as is consistent with good mechanical construction. The insulation of the armature wires is exceptionally thick and firm, almost equal in thickness to that on line wire, and the whole is so firmly put in place that it is hard to see how a short circuit could occur; even in case of an armature section burning out it need only be cut off at the commutator, and the machine will then run successfully until the damage can be repaired; this is a well-known property of Gramme armatures for many sections. The fields are wound with No. 9 wire, and the four coils arranged for three combinations at the switchboard, all in series, two in series and two in parallel, and all in parallel, therefore giving three speeds by this rearrangement.

It will be seen at once that the size of the wire used in this motor is much larger than it has been customary to employ, so far, and the resistance of the machine is therefore singularly low, giving a very high electrical efficiency. So low, in fact, is the resistance that it would be difficult to employ the machine without danger of excessive starting currents were it not for the clutch device through which it drives the truck. This is worked out along the same lines that Mr. Henry has followed in some of his earlier experiments of six or seven years ago, and consists in the well known epicyclic gearing arrangement, capable of running freely when the epicyclic pinion is free to move, and exerting its full power when the pinion is held fast as it can be by the clutch lever. The armature therefore can run all the time, or be allowed to give its full speed before any of the load is thrown on; as soon as the clutch is tightened the clutch can take hold and utilize its momentum in starting the car, thereby avoiding a sudden rush of current that has proved so disastrous to many armatures. The epicyclic gear is enclosed in a tight case and runs in oil, so that the noise is very much diminished, and the wear is much less than with the ordinary exposed gears. It will be noticed that the armature is geared down but once instead of twice as is most other motors, this reduction of gearing being rendered possible by the large size of the armature. The reduction is seven to one instead of twelve to one as in ordinary trucks. A slight modification will allow the armature to be connected directly with the internal gear after the car is underway, thus allowing very high speeds.

An interesting mechanical addition to the motor gear is an automatic brake; the arrangement for driving it is seen in Fig. 1, which gives a perspective view of the truck. Two friction wheels will be seen on the right of the cut, one upon the axle and the other upon the shaft which supports one end of the motor. The latter is arranged with an eccentric operated by a lever, the lower end of which is seen close by it, so that it can be thrown into gear with the friction drum upon the axle when set in motion. By this means it winds up the brake chain and checks the car. This arrangement for a power brake is certainly very simple and is reported to work excellently.

A convenient feature of the Henry truck is the fact that the field magnets can be slid sidewise along the two axles which support their ends, and the armature can then be slipped in the opposite direction so as to expose nearly its entire face, thus enabling small repairs to the armature to be executed quite easily without removing it. The whole design is of striking simplicity and strength, and operating on a suitable track, such as is now generally laid for electric roads, it should give very excellent results. There is great economy in avoiding the multiplication of gearing and also in the use of a single motor? The present machine weighs little over 2,500 pounds, and is of about 30 h. p., thus replacing in power and vastly more than replacing in efficiency more than the two motors ordinarily used. It is a well-known fact now that the employment of two motors leads to mechanical inefficiency. There is every reason to believe that Mr. Henry's present arrangement will show a commercial efficiency of a very gratifying character, and in its proper place—that is, on a good and solid track—its mechanical operation will be entirely satisfactory.

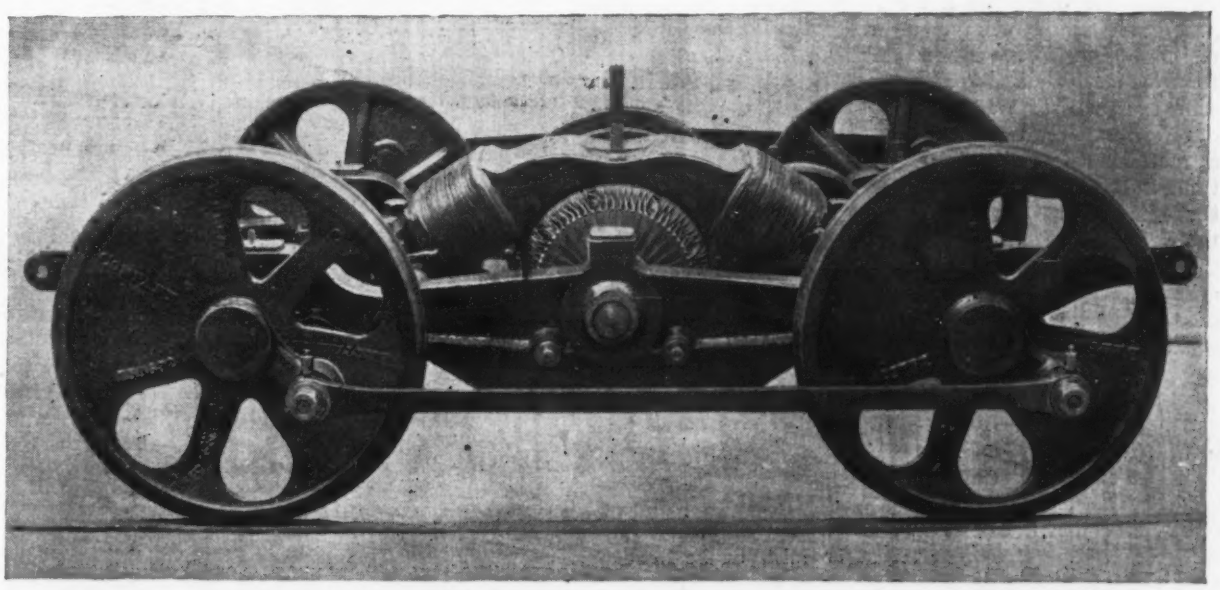


FIG. 2.—THE HENRY ELECTRIC RAILWAY MOTOR AND TRUCK.

The Bell Telephone in the South.

The headquarters of the Bell Telephone Company for the States of South Carolina, Georgia, Florida and Alabama, have been located at Atlanta, Ga. Since the introduction of telephones in the South, the Bell Company has had three districts; with the establishment of the office in Atlanta this number is reduced to two. First district was and is yet composed of Virginia, West Virginia and North Carolina, the headquarters being at Richmond. The second district consisted of South Carolina, of Southwest Georgia and Eastern Florida, with headquarters at Macon. The third district was made up of Northwest Georgia, Alabama and Western Florida, with headquarters at Atlanta. Mr. John D. Easterlin, of Macon, was superintendent of the second district, and Mr. W. J. Cole, of Atlanta, was superintendent of the third. The Bell Company has been thinking of consolidating these two districts for some time past, and decided a few weeks ago to do so. By the consolidation Atlanta becomes headquarters for the second and third districts combined. Mr. John D. Easterlin has been appointed superintendent of the new district, Mr. Cole having resigned his position as superintendent of the third some time ago. The repair shops of the three districts are to be combined and located in Atlanta. Superintendent Easterlin is a native of South Carolina, and has been in the telephone work since the service came South. Previous to the days of the telephone Mr. Easterlin was in the telegraph work. He is a thorough electrician and a very popular gentleman. It is stated that the former superintendent, Mr. Cole, is entertaining a proposition from the Bell company.

Electrical Units.

BY PROF. ARTHUR L. KIMBALL, PH. D.

INTRODUCTORY.

In order to discuss to advantage the relations between the various electrical units and the modes by which they are experimentally determined, it will be well to advance briefly some considerations with respect to units and measurement in general. Measurement is a comparison of that which is to be measured with a unit *of the same kind*. Thus the length of a body is determined by finding how many times greater or less it is than some standard length which is taken as a unit. The velocity of a body is determined by a comparison with a standard or unit velocity; as, for example, when a train is said to have a velocity of 40 miles an hour, the unit velocity is one mile per hour. There must therefore be a unit chosen for every different *kind* of quantity, which is to be measured; thus there must be units of length, mass, time, velocity, force, work, volume, area, etc. It would be possible but exceedingly inconvenient to choose the units of these several kinds without any respect to the relations between them; we might select, for example, a certain length as unit length, and then choose arbitrarily some area as unit area, without any reference to the fact that the simplest unit of area is the square of the unit of length. This is evidently the simplest unit, because by multiplying the length by the breadth of a rectangular area its area is found in terms of this unit, while if any other unit area is employed it is necessary to know its relation to the square of unit length. The inconveniences of choosing units independently are seen even in so simple a case as when it is sought to find the velocity of a body in miles per hour, when the distance which it travels per second is given in inches; the relations between the inch and the mile and the second and the hour must both be remembered and introduced into the calculation.

From these considerations it is evident that as few units as possible should be independently and arbitrarily chosen, and that all others should be derived from these by relations known to exist between them. A system of units obtained in this way is known as an *absolute* system. The units which are arbitrarily chosen are usually those of length, mass and time, and all others are deduced from these more or less directly. The absolute system, which is used by scientific men all over the world, is that in which the centimetre is the unit of length, the gramme the unit of mass, and the mean solar second is the unit of time; this is commonly known as the C. G. S. system of units from the initial letters of the three fundamental units. In English-speaking countries the foot-pound-second system is also in use; but as all electrical units are derived from the C. G. S. system, this only need be considered at present.

In the C. G. S. system the square centimetre is the unit of area, the cubic centimetre the unit of volume, a velocity of one centimetre per second is the unit of velocity, the unit force or one dyne is the force which, acting on a gramme of matter, will increase its velocity at the rate of one centimetre per second in every second. This unit of force is independent of local gravitation force, and so is the same everywhere. When the *force of a gramme* is spoken of referring to the force with which a gramme of matter is attracted to the earth, it is evident that that force is one thing in Baltimore and another in London, but a dyne is the same everywhere and is a force nearly equal to $\frac{1}{980}$ of the weight of a gramme at Baltimore, or slightly greater than a milligram weight; at London the weight of a gramme is greater, so that one dyne is $\frac{1}{981}$ of the weight of a gramme. The unit of work is the erg or the work done by a force of one degree acting through one centimetre. Thus 980 ergs of work are done when a gramme weight is raised one centimetre at Baltimore. It must not be supposed that there is only one way in which the derived units may be obtained from the fundamental ones. There are often many ways in which it might be done, but one is chosen which leads to the greatest simplification in calculation. For example, the unit of force on the C. G. S. system might be taken as the force with which two gramme masses placed at points one centimetre apart would attract each other; but this would give an exceedingly small unit, and one which would be of little use, because in mechanical investigations we usually want to know the effect of forces in giving motion to masses, and therefore the force which gives unit mass unit acceleration, or the dyne, is the most convenient unit. An illustration of the fact that derived units may be obtained in different ways from the same fundamental units is found in the two systems of electrical units, the electromagnetic and the electrostatic systems.

There are two modes of measurement which it may be well to distinguish from each other: 1. The quantity to be measured may be determined directly in terms of the fundamental units. 2. The quantity to be measured may be compared with another of the same kind which has previously been measured in terms of the standard units.

In some processes a mixture of the two methods just mentioned is found most convenient. In many simple mechanical measurements the first method is employed. For example, to find the velocity of a body the distance traversed in one second is measured in centimetres. But when the relation of the derived unit to the fundamental ones is at all complicated it is usual to employ the second method; as, for example, when it is required to find the force which a certain spring exerts when stretched, it is usual to find the weight in grammes required to produce the given stretch by the number of dynes corresponding to a weight of one gramme having been previously determined.

Electrical quantities are ordinarily measured by the second method, as when the resistance of a wire is to be determined it is compared by Wheatstone's bridge with some standard resistance, and the resistance of the standard is found once for all in terms of the fundamental units. The first part of the operation, the comparison of two resistances, is very easily understood and carried out, but the determination of the resistance of the standard coil by measurements which only involve the centimetre, gramme and second is very much more difficult. It is this part of the process of determining electrical units which it is proposed to consider more particularly.

DIMENSIONS OF MECHANICAL UNITS.

The way in which a particular unit is related to the fundamental units of length, mass and time is called its *dimensions*. Thus area has the dimensions of the square of a length, velocity has the dimensions of a length divided by a time, acceleration or rate of increase of velocity with time is of the dimensions of velocity divided by time, or symbolically $\frac{L}{T}$. When a force acts on a mass the acceleration produced is proportional to the force, and the greater the mass the less the acceleration for a given force; this relation is expressed by the formula $F = k\ m\ a$, where F is the force, m the mass and a the acceleration, while k is a constant, the value of which depends on the unit of force which is chosen. If the unit force is so chosen as to make $k = 1$, we have $F = m\,a$, and this equation really defines the unit force. When m and a are measured on the C. G. S. system this equation gives us the C. G. S. unit of force, the dyne. For if $m = 1$ and $a = 1$, then $F = 1$ and the unit force may be defined as that force which will give unit acceleration to unit mass. From this equation it will be seen that the dimensions of force are

$$F = m\,a = \frac{M\,L}{T^2}$$

So also work, which is calculated by the product of the force into the distance through which it acts, has the dimensions $W = FL = \frac{ML^2}{T^2}$.

Since the power which a body possesses of doing work is its energy this is also the dimensions of energy; both are measured by the same unit.

Still another unit which is useful is that of *rate* of work, or power as it is sometimes called, $P = \frac{W}{T} = \frac{ML^2}{T^3}$.

These results may be tabulated thus for reference:

MECHANICAL DERIVED UNITS.

$$\text{Velocity} = v = \frac{L}{T}. \quad \text{Force} = F = \frac{ML}{T^2}. \quad \text{Power} = P = \frac{ML^2}{T^3}$$

$$\text{Acceleration} = a = \frac{L}{T^2}. \quad \text{Work} = W \text{ or } E = \frac{ML^2}{T^2}$$

There are two obvious uses that may be made of these dimensional equations, as they are called.

First, they show what changes in the derived units will result from changing the fundamental units.

Thus if instead of the usual units we were to take 10 centimetres as the unit of length, and 10 seconds as the unit of time, the new unit of velocity would be the same as on the C. G. S. system, but the new *unit* of *acceleration* would be only one-tenth as great as the C. G. S. unit, and so a body having a velocity of two C. G. S. units will have the same velocity as the new system; but if it has an acceleration of two C. G. S. units, its acceleration on the new system will be expressed by 20. Because the smaller the unit used in measuring a given quantity, the greater the number of times which the unit is contained in the given quantity; just as if a gallon of water is measured in quarts the quantity is expressed as four units; if measured in pints there will be eight units.

A second use of these dimensional relations is that they afford a first test of the accuracy of physical equation. For in every equation the algebraic sum of all terms having the same dimensions must be equal to zero. Thus if a term having the dimensions of energy were to be found equal to another whose dimensions were different, we should be certain that some error had been made.

CLASSIFICATION OF ELECTRICAL UNITS.

There are two great classes of electrical units which are in common use, the electrostatic and the electromagnetic classes. They differ in that the derived units are obtained from the fundamental units in entirely different ways in the two cases. The only electrostatic system which is at all in vogue is that based on the C. G. S. units. There are two electromagnetic systems, in one of which the fundamental units are the centimetre, gramme and second, while in the other the unit of length is one-quarter the circumference of the earth, the unit of mass is one one-hundred-thousand-millionth of a gramme, the unit of time is the second. This last is called the *practical* system, and is the one to which all commercial units belong. The reason why these particular fundamental units are chosen will appear later. The classification of the various systems is exhibited as follows:

Absolute systems of electrical units.....	Electrostatic class.....	C. G. S. system.
	Electromagnetic class	C. G. S. system.
		Practical system

CLASS I.—ELECTROSTATIC UNITS.

Experiment shows that the force with which two quantities of the same kind of electricity q and q^1 repel each other is proportional to the product of the two quantities and inversely as the square of the distance between them. This is expressed by the formula $F = b\frac{q\,q^1}{r^2}$ where b is a constant for any one medium. In establishing this law any convenient quantity of electricity whatever may be taken as a unit; for example the charge which a certain little ball gets when touched to the top of the knob of a certain Leyden jar kept charged to a constant potential may be employed. But some standard unit of quantity must evidently be chosen which shall be convenient for electrostatic calculations. The unit chosen in the electrostatic system is that quantity of electricity which if concentrated at a point at unit distance from another equal quantity will repel it with a unit force when in vacuum. Practically the force between two electrified bodies is so nearly the same in air as in vacuum that it may be said that unit quantities of electricity unit distance apart in air at ordinary pressure repel each other with unit force.

This definition evidently fixes the amount which shall be called unit quantity as soon as the units of length and force are adopted, and the expression for the force between two quantities in air becomes simply $F = \frac{q\,q^1}{r^2}$, the constant b being equal to 1 when the unit quantity given above is assumed. For, obviously, if q and q^1 are each equal to 1, and the distance between them, r, is also 1, F will be 1 also.

The dimensions of quantity on this system of units may be thus found. From the above equation $q\,q^1 = F\,r^2$. So that q has the dimensions $\sqrt{F\,L^2}$,

but $$F = \frac{M\,L}{T^2} \therefore q = \sqrt{\frac{M\,L^3}{T^2}} = M^{\frac{1}{2}}\,L^{\frac{3}{2}}\,T^{-1}.$$

This equation shows the relation between the unit of quantity and the fundamental units of length, mass and time, and therefore we should use this equation, if for example, it were required to compare the unit quantity on the C. G. S. system, with that when the foot-pound and second are taken as fundamental units.

The unit of quantity being decided upon, all the other electrical units are readily deduced from it, so that the equation $F = \frac{q\,q^1}{r^2}$ is sometimes known as the fundamental equation of the electrostatic system.

The unit *current* is one such that unit quantity of electricity passes in unit time through any imaginary surface across the conductor. Its dimensions will therefore be $\frac{q}{T}$, for to find the strength of current the quantity passing in a given time would be divided by the time, the dimensional equation will then be $I = \frac{q}{T} = M^{\frac{1}{2}}\,L^{\frac{3}{2}}\,T^{-2}$

The *potential* at a point (relative to the earth) is the work that must be done to bring unit quantity of electricity from the earth to the given point, so is of the dimensions

$$V = \frac{W}{q} = \frac{M\,L^2\,T^{-2}}{q} = M^{\frac{1}{2}}\,L^{\frac{1}{2}}\,T^{-1}$$

The *capacity* of a conductor is the quantity of electricity with which it must be charged to raise its potential unit amount. By the capacity of a condenser is always meant the capacity of one coating when the other is connected with the earth. Thus $q = C\,V$. Capacity is then of the dimensions $\frac{q}{V} = L$. That is, capacity in electrostatic measure simply depends on the unit of length. Thus the capacity of a conductor may be represented by a line of proper length. If the centimetre is the unit of length, then the capacity of that conductor will be numerically equal to the length of that line in centimetres; if the foot is taken as unit length, then the length of the line in feet will express the capacity of the conductor.

Another important conclusion is that the capacities of two similar systems are directly proportional to their linear dimensions; thus a sphere of two feet radius will have twice the capacity of one whose radius is one foot.

ELECTROSTATIC MEASUREMENT IN C. G. S. UNITS.

The simplest measurement to make directly is that of *capacity*. If we start with the equation $F = q\,q'$, it may readily be shown that the capacity of a sphere is numerically equal to its radius; a standard of capacity could thus be obtained having a known capacity of 10 C. G. S. units by simply taking a sphere of radius 10 centimetres and supporting it away from all inducing bodies.

But as in practice it is impossible to get away from the inducing action of surrounding bodies, a better plan is to make a standard condenser of two concentric spheres with air between them; the outer sphere is connected to the

earth, while the inner one is charged. The capacity of this arrangement, as is well known, is

$$C = \frac{r_1 r_2}{r_1 - r_2}$$

where r_1 is the radius of the inner surface of the outer sphere and r_2 is the radius of the outer surface of the inner sphere. If these measurements are made in centimetres the capacity is known in electrostatic C. G. S. units, and the capacity of any other Leyden jar or condenser may be compared with it by any of the well-known methods of comparing capacities.

The *potential* of a charge may be determined by the use of the attracted disc guard ring electrometer of Sir Wm. Thomson. In this instrument the difference in potential between two plates is found by actually measuring the attraction between them either by having one plate suspended from a balance so that the attractive force can be weighed, or by counterbalancing the force by means of a spring which has been tested so that the force required to stretch it any given amount is known. In the guard ring type of instrument a central disc is cut out of one of the plates and the attraction is measured only between this disc and the other plate, though the ring surrounding the disc is kept at the same potential as the disc and both are in the same plane; so that it still is like a single plate, except for the narrow crack separating the disc from the surrounding ring. The object of the guard ring, as it is called, is to make more uniform the distribution of electricity over the central disc, for it is as though the attraction was measured between the central parts of two plates over which the distribution is nearly uniform, while the rapid increase in density toward the edges of the plate only affects the distribution on the guard ring. When the distribution is uniform over the attracted disc it is found that

$$V = d\sqrt{\frac{8\pi F}{S}}$$

where V is the difference in potential in electrostatic units, d the distance between the two plates, S the surface of the attracted disc, and F is the force of attraction. If d is measured in centimetres, S in square centimetres and F in dynes, then V will be found in electrostatic C. G. S. units.

To measure a given *quantity* in these units we have only to charge our standard condenser, or any other condenser whose capacity has been determined by comparison with the standard, with the given quantity of electricity, and then measure the difference in potential between the two surfaces of the condenser by means of the guard ring electrometer; then since V and C are determined, q is known by the relation $q = V C$.

The above are the most important quantities to be measured on the electrostatic system, and are all that we need consider here.

CLASS II.—ELECTROMAGNETIC SYSTEMS OF UNITS.

There are two important electromagnetic systems, the C. G. S. and practical systems.

This class of units has grown up from the selection of units which are convenient in the measurement of the magnetic effects of currents, just as the electrostatic units are particularly convenient in calculations involving electrostatic phenomena. We shall find that the electromagnetic unit of quantity is quite different from the electrostatic. We may roughly liken them to two different modes of measuring water. Water may be measured by quarts, or if it were more convenient the quantity flowing through a one-inch pipe in one minute under a given fall in pressure per unit length might be assumed as the unit.

The electromagnet system is built up, starting with a unit magnet pole and choosing the other units so as to simplify the relation between magnetic and electric phenomena as far as possible.

Starting with the experimental relation $F = \frac{m\, m^1}{r^2} k$,

where F is the force between the two magnet poles whose strengths are m and m^1, and which are a distance r apart, k being a constant which depends on the particular units which are employed, a magnet pole is said to have unit strength which repels an equal magnet pole, unit distance away, with unit force in air. In this case $k = 1$ when the medium is a non-magnetic one, like air, and the expression becomes $F = \frac{m\, m^1}{r^2}$.

To give a concrete notion of what the unit pole is as defined by this equation, it may be noticed that on the C. G. S. system a unit magnet pole is one which, if placed one centimetre from another equal pole, will repel it with a force which is a little more than a milligramme weight.

From the form of the above equation, it is seen that the magnet pole is related to the fundamental units of length, mass and time in exactly the same way as is the unit of quantity of electricity on the electrostatic system; the dimensions of magnetic pole are, therefore, expressed thus:

$$m = M^{\frac{1}{2}} L^{\frac{3}{2}} T^{-1}.$$

A *magnetic field* of unit strength is one in which a unit magnet pole is acted upon with unit force. Representing strength of field or magnetic intensity by H, we have, when a magnet having poles of strength m is put in the field, the force on each pole of the magnet is $F = H m$.

So $H = \frac{F}{m}$ and the dimensional equation becomes

$$H = M^{\frac{1}{2}} L^{-\frac{1}{2}} T^{-1}.$$

In this system the unit of *current* is chosen with reference to its magnetic effect. By reasoning based on the fundamental facts of the magnetic effects of electric currents, it may be shown that if we had a thin sheet of steel of uniform thickness, and magnetized uniformly throughout so that all one surface of the sheet was a north pole and all the other surface was a south pole, then whatever the shape of this magnetic shell, as it may be called, whether flat or bent in any way, it will be possible to exactly neutralize its magnetic action at any point in space outside the substance of the shell by an electric current of suitable strength made to flow around the edge of the shell. Or otherwise stated, the magnetic effect of a magnetic shell may be exactly reproduced by causing an electric current of suitable strength to flow in a fine wire which is bent into exactly the same shape as the edge of the shell. The current strength employed must be the same for all magnetic shells of the same *strength*, whatever their shape, defining the *strength* of a magnetic shell by the product of its thickness by the intensity of its magnetization. It would, therefore, be suitable to call unit current that which when flowing in a wire will produce exactly the same magnetic field at every point as would be produced by a magnetic shell of unit strength. This is the definition of unit current which is adopted in the electromagnetic system.

Let us consider this unit from another point of view which may be more easily grasped. Suppose a current to flow in a wire bent in a circle whose radius is r. We know that a magnetic field of force will be produced, and at the centre the force will be at right angles to the plane of the circle. In this case every part of the current is equally distant from the centre of the circle and similarly directed with respect to the direction of the force at that point; so that the force at the centre will be proportional to the strength of current, to the length of the conductor, and inversely proportional to the square of its distance from the centre, or expressed in a formula:

$$H = f\frac{2\pi r I}{r^2}$$

where H is the strength of the field or intensity of the magnetic force at the centre, r is the radius and I is the current strength, while f is a constant which depends on the units employed. If the unit current is so chosen as to make $f = 1$, the expression becomes simply

$$H = \frac{2\pi I}{r}$$

or *unit current* is one which, flowing in a circle of unit radius, will produce a magnetic field of force at the centre of strength 2π, or unit magnetic intensity will be produced at the centre by every unit length of the circular current. This way of defining unit current gives exactly the same result as that where it is defined from its power of replacing a magnetic shell whose edge is in the wire carrying the current. This then may be taken as the electromagnetic measure of current. Its dimensions will be from the above equation,

$$I = \frac{r H}{2\pi} = M^{\frac{1}{2}} L^{\frac{1}{2}} T^{-1},$$

since 2π is merely a numerical factor and has no relation to the fundamental units.

The unit of *quantity* will obviously be the quantity of electricity which will pass any plane across a conductor in unit time, when unit current is flowing. If the second is the unit of time, it will be the quantity which passes per second when unit current is flowing.

The whole quantity passing will be the current multiplied by the time

$$q = I t,$$

which gives as dimensions of $q = M^{\frac{1}{2}} L^{\frac{1}{2}}$.

The unit *potential* may now be found from the fact that the work done in carrying a quantity of electricity from one point to another is equal to the difference in potentials multiplied by the quantity of electricity. The potential of a body will then be unity as compared with the earth, when unit amount of work is done in causing unit quantity of electricity to flow from the earth to the body. This gives $W = q V$.

So for the dimensions of V we find $V = M^{\frac{1}{2}} L^{\frac{3}{2}} T^{-2}$. Now by Ohm's law *unit resistance* is defined as that resistance through which unit current will flow when the difference in potentials of its extremities is unity; this gives the equation

$$R = \frac{V}{I}$$

Thus for its dimensions we have $R = L T^{-1}$; that is, it has the dividing of a length divided by a time which is the same as the velocity.

A word of caution must be here interposed, as the fact that resistance has the dimensions of velocity in this system of units has sometimes been taken as indicating that an electrical resistance is of the *nature* of a velocity; but that this inference is wholly unwarranted by the premises is readily seen when it is remembered that the dimensions of resistance on the electrostatic system are those of the *reciprocal* of a velocity, viz., $L^{-1} T$.

All that we are justified in asserting in consequence of the dimensions of R being $\frac{L}{T}$ is that if the fundamental units are changed in any way, then the value of a given resistance will be changed in exactly the same proportion as a given velocity would be changed by the same transformation of units.

The *capacity* of a condenser is determined by the quantity of electricity required to raise its potential by unit amount, and a condenser is said to have unit capacity which requires unit quantity of electricity to raise its potential by unity.

Thus $$C = \frac{q}{V} = L^{-1} T^2$$

On the electrostatic system the dimensions of capacity were found to be that of a length, and it was inferred that the capacities of condensers were simply proportional to their linear dimensions. If this is true on any one system of units it must be true for every one, and so must be true also in the electromagnetic system.

This conclusion is not inconsistent with the dimensions as found on the latter system, for the unit of *time* enters into the dimensions; and so although, so far as the unit of length is directly concerned, it would seem as though the capacity would be decreased by increasing the linear dimensions, yet the relation of the condenser to time is also changed with its changed dimensions, in such a way that the capacities of two similar condensers are still in the same ratio as their linear dimensions.

(To be continued.)

The Construction and Use of Electrical Testing Apparatus.

BY CHARLES P. FREY, CHIEF ELECTRICIAN OF THE GREELEY ELECTRICAL LABORATORY.

V.

The Thomson Galvanometer.—Resistance boxes, coils, keys, bridges, balances, commutators, etc., are all of course useful within their scope, but, despite all that can be said in their favor, they dwindle into insignificance in comparison with an instrument which, when making resistance or insulation tests, is practically indispensable — a galvanometer.

"Their name is legion," but when the highest attainable efficiency is required, a galvanometer of the reflecting type invented by Sir William Thomson is invariably employed.

Its salient feature consists in suspending a very small and light astatic system by means of a single fibre of unspun silk within coils constructed of highly insulated copper wire. The astatic system usually consists of eight small bars of steel, magnetized to saturation. Four of these are fastened to a small plane or concave mirror, the others to a small aluminium vane. This vane is rigidly connected with the mirror by means of a straight wire of aluminium. The polarity of one set of magnets is the reverse of the other, the upper set being generally north-seeking when the mirror faces west, and, owing to slightly increased dimensions, predominating. Instead of using a pointer, such as is employed on direct reading galvanometers, an indicator is ingeniously contrived by means of a beam of light which is thrown against the small mirror attached to the system, and reflected from it against a graduated scale. Since a beam of light has no weight, it is evident that the sensitiveness, or rather the facilities for noting any movement of the system, will be greatly increased by prolonging this "pointer" as far as may be expedient. A brass rod extends from the top of the instrument, upon which slides a weak, permanent magnet.

One of the notable advantages of this instrument is the ease and rapidity with which one set of coils can be removed and replaced by another set of higher or lower resistance. These coils are merely slid into fixed rings, and their pendent terminals fastened to small binding posts provided for the purpose. This can be accomplished without disturbing the astatic system, endangering the fibre, or even removing the frame which holds the glass case together. The glass plates at the front and back slide in grooves, and can be immediately removed. When replaced they effectually prevent dust or moisture from penetrating. Another feature is the pair of hinged frames which carry the coils. These frames are hinged to an upright plate permanently fastened in the centre of the case and provided with proper apertures. The rings into which the coils slide are fastened to these frames, and by releasing a screw on either side the frame may be thrown out without detaching the coils, the flexible terminals yielding sufficiently. The astatic system, mirror and fibre may then be inspected and adjusted.

Two sets of coils are used, one pair being above the other. The wire of which these coils are constructed is highly insulated, and is wound upon the spools in conformity with a law of Sir William Thomson, several sizes of wire being employed, the result of which is to secure the greatest effect attainable in a limited space with a minimum amount of wire. The rubber base of the instrument is provided with eight binding posts for outside connec-

tions, and eight more smaller ones, to which the terminal of the coils are fastened. Underneath the base will be found heavy wire connections running from the inner binding posts to the outer. These connections, represented by dotted lines on Figs. 19, 20, 21 and 22, should not be disturbed unless the galvanometer is to be used for some special purpose. For general work, a great variety of combinations can be obtained by simply altering the time connections from one binding post to another. Fig. 19 shows the manner in which the connections are arranged when the coils are coupled for maximum effect and highest resistance. Binding posts 2 and 3, 4 and 5, 6 and 7, are respectively connected together by thick copper wires. By tracing out the dotted lines, it will be seen that the coils are in series. Fig. 20 shows all the coils connected together in multiple. The series resistance is thereby reduced to its one-sixteenth. The connections are 1 and 3, 3 and 5, 5 and 7, 2 and 4, 4 and 6. Fig. 21 illustrates a method by which the total resistance is reduced to one-fourth. Connections are 1 and 3, 2 and 3, 4 and 8, 6 and 7. When two independent currents are to be used at the same time, 2 and 3, 6 and 7 are to be connected, as shown on Fig. 22. One pair of terminals are connected at the binding posts 1 and 4, the

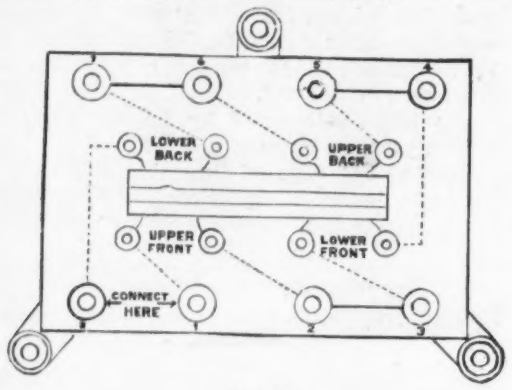


Fig. 19.

others at 5 and 8. A great many other combinations are possible, and can be as easily arranged.

The short connections between binding-posts 2 and 3, 4 and 5, 6 and 7, as shown on Fig. 19, consist of thick copper wires with hooks bent at their ends. These are furnished with the instrument. The long connections shown on the other diagrams should be constructed of well insulated copper wire, the size being preferably No. 14. The insulation must necessarily be removed from the ends, and the wire scraped or cleaned with emery paper. If bare wire is used, care should be exercised that the wires do not touch each other.

Adjusting a Thomson Galvanometer for General Testing.—When purchased, this instrument is provided with a compact case, from which it should invariably be removed when in use. The very slovenly custom of attempting

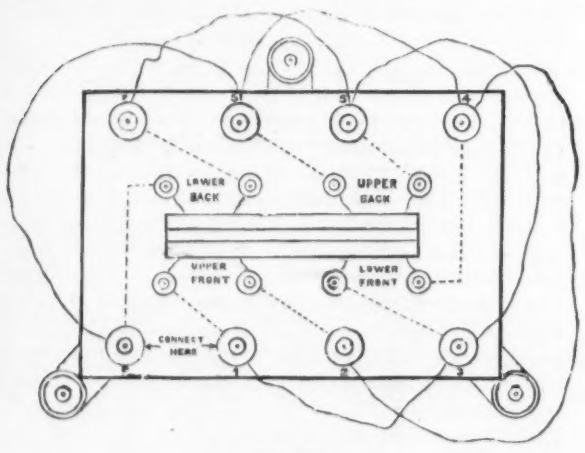


Fig. 20.

tests with an incased and hence unadjusted and perhaps partly disconnected or poorly insulated galvanometer is not to be recommended. The exposed parts should be properly cleaned, if necessary, by the vigorous application of a piece of dry cloth. (The author recalls an instance where an electrician (?) excused himself for the anything but neat appearance of the rubber and brass parts of his instruments on the plea that he feared if he undertook the task of cleaning them a static charge might be developed through friction, and interfere with the accuracy of his results! Whatever ground for alarm there may have been in this supposition, it hardly seemed to warrant the accumulation of a crust of grease and dirt of several months' standing. Possibly an instrument *might* be cleaner if occasionally wiped off a few hours before using, or immediately afterwards, rather than not at all.) To resume, the galvanometer should then be placed in a locality where it will be free from all disturbing influences, such as moving machinery, passing vehicles, or uneasy but curious visitors with plenty of spare time on their hand, and big pocket-knives, keys, etc., on their persons. No good results can be secured if the apparatus is placed on an upper floor, since the least vibration will be amplified, and the spot of light on the scale, instead of moving sedately back and forth, will describe a variety of contortions similar to Lissajous' curves, which, however interesting and pleasing in the abstract, slightly retard the work undertaken and demoralize the operator. When tests are made in a brick or stone building, a good plan is to fasten a solid shelf directly to the wall. In a wooden building, a solid column of brick or stone should be built from the ground to a suitable height. If it is necessary to run this column through a floor, a space of about one-half inch must be left open around it.

Having provided a suitable support, place the galvanometer on it with its front facing west. Particular at-

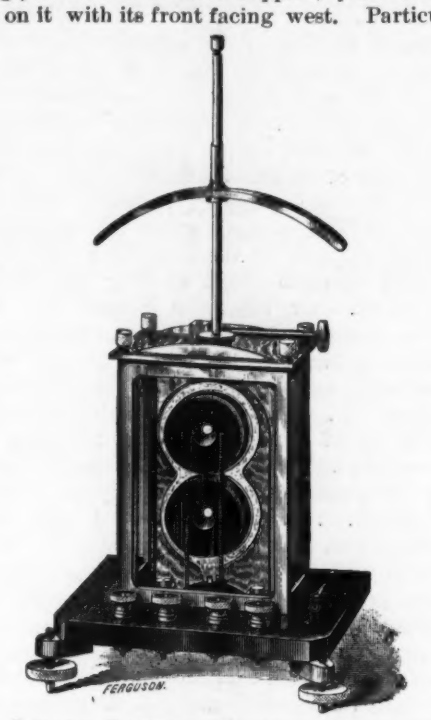


Fig. 23.—Square Pattern, Thomson Reflecting Galvanometer.

tention must be paid to the position of the galvanometer relative to the points of the compass, or no good results can be secured.

The astatic system can be used on the "plumb" principle, together with the spirit levels for adjusting the base horizontally. The astatic system and fibre should hang in the exact centre of the fixed upright plate, without interfering. The directing magnet should be temporarily removed, and a lamp, stand and scale or a reading telescope placed in position. Another firm support should be provided for either of these. The focal length of the mirror and lens is generally one metre (39+ inches).

It is best not to move the galvanometer often, since the most concordant results are secured if it is left undisturbed, and any sudden shock is liable to break the fibre, which an inexperienced person will find great difficulty in renewing, probably damaging the system in the attempt. The directing magnet should now be replaced, with its *south-seeking pole pointing north*, and, if the instrument need not be very sensitive, may be pushed down near the case. The directing magnet is next to be turned until the spot of light is brought to its proper position at zero. This galvanometer may be used in any position, independent

Fig. 24.—Tripod Pattern, Thomson Reflecting Galvanometer.

of the directive action of the earth's magnetism, by strengthening the directing magnet; but this plan is *not recommended*, as the instrument will lose in sensitiveness, and cannot then be used for delicate tests unless an additional, weaker, directing magnet is obtained for the purpose.

Adjusting a Thomson Galvanometer for Minimum and Maximum Sensitiveness.—An absolutely "astatic" system would (paradoxically it may seem) be useless because it would be perfect. In every astatic system employed for practical purposes, one of the two magnets, or one of the two sets of magnets (generally the upper), is intentionally made stronger than the other. The effect of this is to permit the system being influenced by the directive action of the earth's magnetism, *i. e.*, causing it to point north and south. The principle of a compound magnet being the same as that of a simple magnet, we will for the sake of simplicity consider the astatic system as having but two magnets, the upper being slightly longer than the lower. If the directing magnet is entirely removed, the system evidently will continue to point north and south as before. It is, however, the upper half of the system which points its poles as a compass needle would. The lower half of the system is (much against its inclination) compelled to hang in a position diametrically opposite to that into which it would move if left to its own devices. If now the directing magnet is replaced with its south-seeking pole pointing north, it will exert its influence chiefly on the upper half of the astatic system, and, in conformity with the axiom "Unlike poles attract," will hold it in position. Its tendency, thus arranged, is, therefore, to prevent the system from moving out of the plane of the earth's magnetic line. Hence a current sent through the coils, in order to move the needle, must overcome the combined influence of the earth's magnetism and that of the directing magnet. The galvanometer is, therefore, arranged for minimum sensitiveness. Lowering the direct-

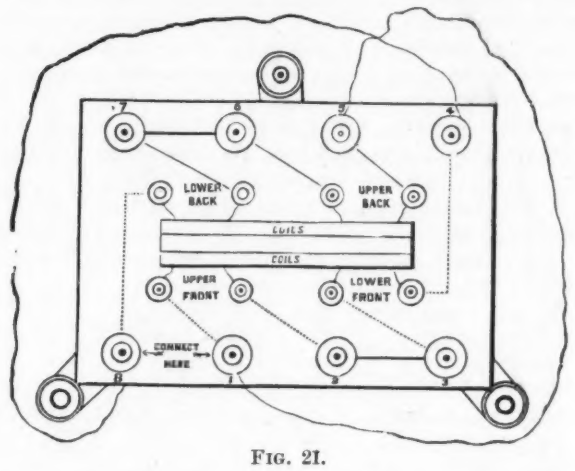


Fig. 21.

ing magnet will, under these conditions, decrease the sensitiveness of the galvanometer.

To secure maximum sensitiveness, the directing magnet is placed with its north-seeking pole pointing north, and high up on the rod. The upper half of the astatic system is under these conditions no longer anxious to keep in line with the directing magnet. On the contrary, since "Like poles repel," if the directing magnet (placed as last stated) were strong enough, its influence would tend to reverse the astatic system. Since, however, the directing magnet is only weakly magnetized, this will not take place until the

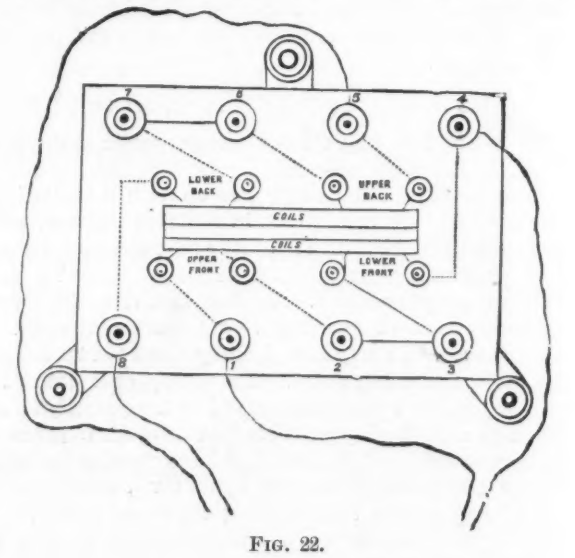


Fig. 22.

magnet is pushed down the rod to within a few inches of the case. The astatic system will then be suddenly "upset," the back of the mirror facing west, and the north pole of the upper half of the astatic system ingloriously pointing south, while the north pole of the lower magnet on the system, now released from bondage, is triumphantly pointing north. This, however, is a condition of affairs which it was not intended should ensue. The directing magnet must, therefore, be pushed slowly up again until a position is found by trial where the influence of the directing magnet and the earth's magnetic attraction exactly counterbalance each other. The astatic system will then remain indifferently in any position, equally influenced by contending forces. After admiring this phenomenon, the directing magnet should be raised a little more, in order to give the upper magnet of the system sufficient strength to recover its dignity and its legitimate position. The galvanometer will then be adjusted for maximum sensitiveness. The "swing" of the system, instead of being short and quick, will be slow and measured. An exceedingly feeble current sent through the coils will cause a large deviation from the zero line, and tests requiring unusual accuracy may be undertaken. When adjusting the spot of light on the scale, if the galvanometer is arranged for minimum sensitiveness, the system will turn with the directing magnet when its position is altered. Adjusted for maximum sensitiveness the system will move in the opposite direction.

The Baxter Electric Railway Car.

In a former description* accompanied by illustrations of the new Baxter motor and truck, a complete account of the first public trial of that new system of electric traction was given. Some additional details of the electrical construction of this somewhat unique system, together with a different view of the motor and an illustration of the car as it appeared during the trial trip, which are herewith presented, will be of interest to our readers.

Fig. 1 shows a top view of the truck as it appears when looking down upon it from the interior of the car. The trap doors in the floor have been removed so that both motors are visible, together with the resistance coils, which are placed, as shown in the cut, between the two motors and underneath the floor of the car. The brushes are placed 45 degrees apart and are both on the upper side of the commutator, so that they are easily accessible. The brushes are of carbon and only two are used upon each motor, although the motor is an eight-pole machine. The weight of the four field magnets is 340 pounds, and that of the armature, together with the commutator and shaft, is 355 pounds. The motor proper will weigh perhaps about 900 pounds, and, making an allowance of 500 pounds for the gears, shaft, etc., the total weight will be something less than 1,500 pounds. Although the armature is 18 inches in diameter, the field magnets are so placed that the total vertical height of the motor is less than 20 inches. The iron cores of the magnets weigh about 70 pounds each, and are wound with 203 turns of No. 9 wire, the total weight of which is 18 pounds. The resistance of the four field coils when connected in series is 1.4 ohms. The armature has 136 sections, each section being wound with 12 turns of No. 11 wire. The total resistance of the armature is 1.03 ohms. The rheostat, which is shown placed beneath the floor of the car, is fireproof in its construction, and is utilized in connection with the lightning arrester as a means for protecting the armature from damage by lightning. This is done by connecting the lightning arrester between the trolley wire and the rheostat, so that the counter-electromotive force of self-induction acts in such a way as to shunt the lightning stroke through the ground wire to the earth. The rheostat is intentionally constructed so that it has a large self-induction.

Fig. 2 shows the appearance of the car during the trial trip at Baltimore, which was described in our former article. As will be seen, the car was given a severe test, almost every available inch of space upon the car being occupied by passengers.

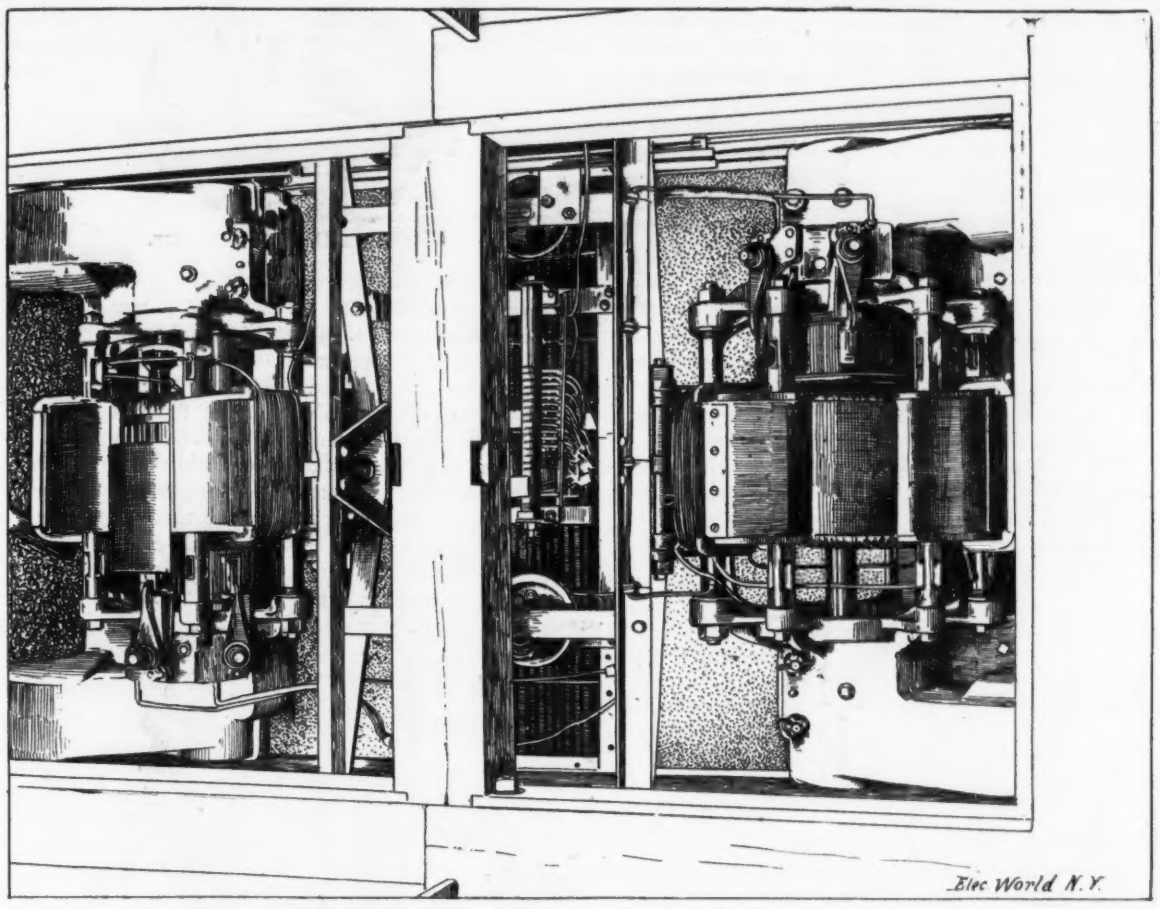


FIG. 1.—TOP VIEW OF BAXTER ELECTRIC CAR TRUCK.

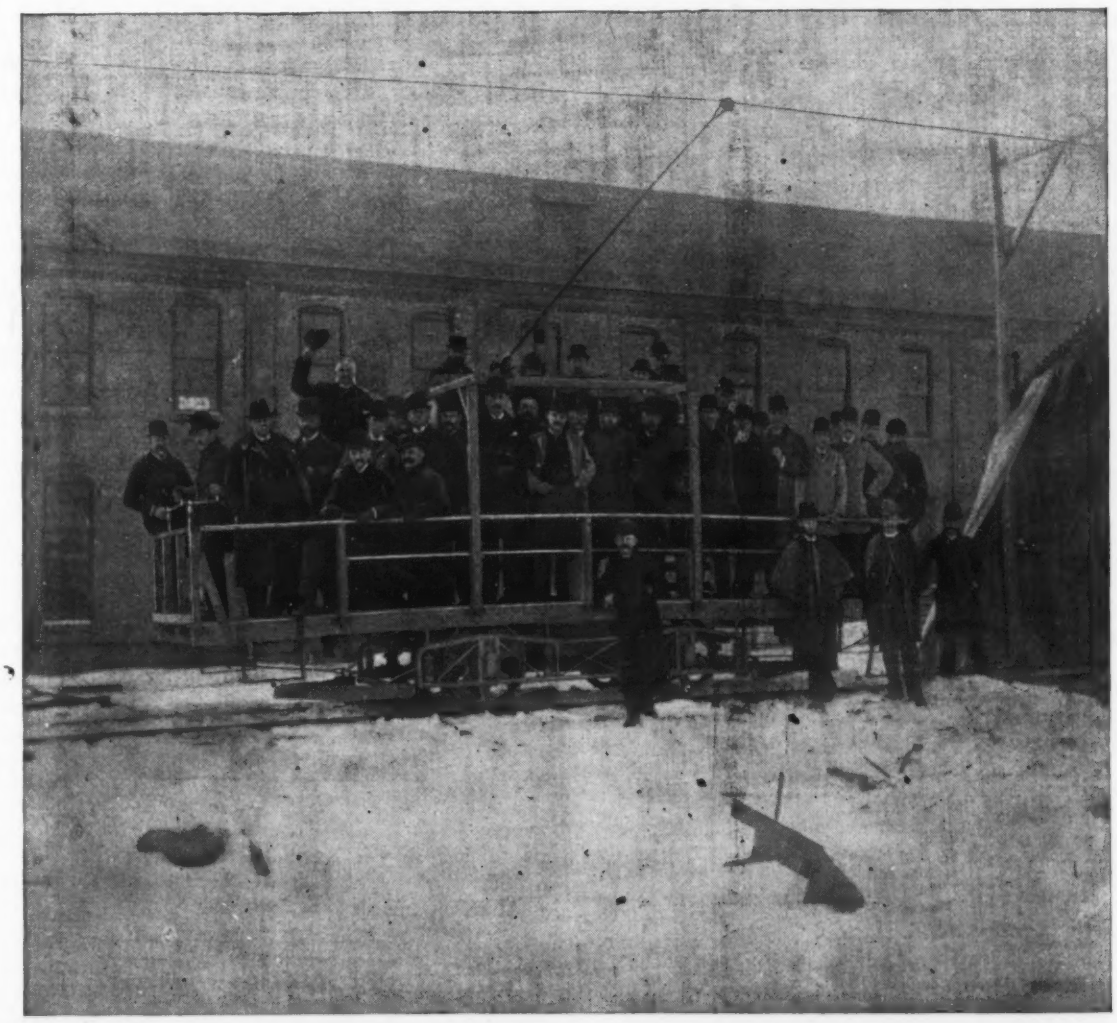


FIG. 2.—FIRST PUBLIC TRIAL OF THE BAXTER ELECTRIC RAILWAY CAR.

*See THE ELECTRICAL WORLD, Jan. 3, 1891.

Rate of Electric Discharge.

In a recent number of the *Journal of the Physico-Chemical Society of Russia*, M. P. Bakhmetieff states that he has repeated the experiments of M. Nacarri on the loss of charge undergone by an electrified body when close to an electric spark, placing the whole arrangement under a bell glass and filling it with different gases. Generally speaking, the electric spark accelerated the discharge, but charges of positive sign were the more rapidly dissipated in carbonic acid, and in coal gas, while negative electrification disappeared the more rapidly in air, hydrogen, and oxygen. M. Bakhmetieff attributes these results to an unstable molecular allotropic modification of the gases by the electric spark which renders them conducting, but only to electricity of one particular sign.

M. A. Nacarri in the *Atti della R. Academia delle Scienze di Torino*, Vol. XXV., states, with reference to some further experiments of his, that the influence of the electric spark on the rate of discharge of an electrified body is much diminished by the presence of vapor of water, alcohol, essence of turpentine, ether and petroleum. He further calls attention to the fact that the presence of a piece of phosphorus near an electrified metal ball causes it to rapidly discharge. This phenomenon is, he says, apparently closely connected with phosphorescence, since it only takes place if the phosphorus emits a glow reaching to the electrified body. The phenomenon ceases in the presence of bodies, such as essence of turpentine, which cause phosphorescence to disappear.

Electricity on the Transandine Railway.

The application, to an important extent, of the transmission of power by electricity, is in course of preparation on the section of the Transandine line between Santa Rosa, Chili, and Mendoza, Argentine Republic. The range of the Andes is traversed by a series of tunnels through very hard rock. The drilling machines for opening the highest of these tunnels, at an elevation of 10,150 feet, cannot be worked by coal, owing to the enormous cost of transport, nor is there any water power immediately accessible. On the Chilian side, at about one and three-quarter miles distant from the face of the tunnel, a waterfall of about 590 feet is found. This will work 12 Girard turbines of 80 h. p., at 700 revolutions per minute each. The turbines will each work a dynamo of 400 volts and 135 ampères. At the face of the tunnel the current is converted into mechanical power by 10 motors, each of 60 h. p.

Copper Production of the United States.

The *Engineering and Mining Journal*, in the first issue of the year, gives an elaborate review of the copper production of the United States, from which the following figures are taken, showing statistics for the past nine years:

	1882.	1883.	1884.	1885.	1886.
	Pounds.	Pounds.	Pounds.	Pounds.	Pounds.
Lake Superior	57,155,991	59,702,404	69,353,202	72,147,889	79,918,460
Arizona	17,984,415	23,874,963	26,734,345	22,706,366	16,000,000
Montana	9,058,284	21,664,346	43,093,054	67,798,864	57,611,485
New Mexico	839,489	823,511	59,450	79,839	558,385
California	826,695	1,600,862	876,166	496,028	430,210
Colorado	1,494,000	1,152,652	2,013,125	1,146,460	409,306
Utah	605,780	341,885	65,526	166,199	500,000
Wyoming	100,000	962,468	.....	.....	.....
Nevada	350,000	288,077	100,000	8,871	50,000
Idaho	.....	.....	46,667	40,381	.....
Middle States	294,695	324,706	232,114	193,000	.....
New England	1,555,000	612,124	904,423	211,602	315,719
Southern States	400,000	395,175	317,711	40,199	29,811
Lead refiners	125,000	782,850	950,870	910,141	1,282,496
Domestic production	90,819,458	115,526,053	144,916,653	165,875,483	157,006,578
Imported ores	1,000,000	1,625,742	2,858,754	6,056,841	4,500,000
Total production	.....	117,151,795	147,805,407	170,962,324	161,506,578
Stocks, Jan. 1	91,819,458	.....	30,000,000	30,000,000	35,006,000
Available supply	.....	.....	177,805,407	200,962,324	196,506,578

	1887.	1888.	1889.	1890.
	Pounds.	Pounds.	Pounds.	Pounds.
Lake Superior	76,028,697	86,587,424	87,504,163	99,570,000
Arizona	17,790,000	33,200,000	32,933,000	35,720,000
Montana	78,699,677	98,500,000	101,539,353	122,950,000
New Mexico	283,664	1,631,271	3,400,000	870,000
California	1,600,000	1,570,021	1,700,000	2,140,000
Colorado	2,012,027	1,621,100	3,100,000	6,760,000
Utah	2,500,000	2,131,047	2,400,000	600,000
Wyoming	.....			
Nevada	.....			
Idaho	.....			
Middle States	.....	3,240,725	3,000,000	3,900,000
New England	200,000			
Southern States	.....			
Lead refiners	2,432,804			
Domestic production	180,920,524	218,481,588	238,576,000	272,510,000
Imported ores	3,750,000	5,000,000	5,100,000	6,100,000
Total production	184,670,524	223,481,588	243,676,000	278,610,000
Stocks Jan 1	40,000,000	40,000,000	75,000,000	65,000,000
Available supply	224,670,524	263,481,588	318,676,000	343,610,000

The average price of lake copper at New York for each month of the year 1890 was as follows: January, 14¼c.; February, 14⅛c.; March, 14⅛c.; April, 14⅛c.; May, 15⅛c.; June, 16c.; July, 16⅛c.; August, 15⅝c.; September, 17c.; October, 16⅞c.; November, 16⅛c.; December, 15⅞c.; for the year, 15¾c.

The Emerson Switchboard Hook.

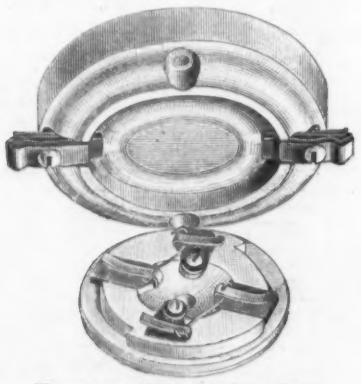
A very simple arrangement, by means of which good contact between the different line terminals upon a switchboard is secured, is shown in the accompanying illustration from which its operation will be readily understood. It is placed upon the market by the Emerson Electric Manufacturing Company, of St. Louis, Mo. It is a simple, strong and well made hook, and when placed in the position shown in the cut is locked into its socket, and cannot possibly get loose or give rise to a poor or trouble-

Emerson Switchboard Hook.

some contact. The hook is designed for use on any style of arc light switchboard, and appears to be a very convenient accessory to central station operation.

A Novel Cut-Out.

Any device which will facilitate the installation and maintenance of electrical systems is necessarily of interest to many of our readers; especially is this true if the device is one in general use as is the ceiling rosette or cut-out, a novel form of which we illustrate in the accompanying figures. This cut-out, which is manufactured by the Emerson Electric Manufacturing Company of St. Louis, seems to be a new departure to some extent from existing forms and to embody several important features of convenience and design. Chief among these is the use of "spring clips" to hold the fuse wires, instead of the usual screws and washers. The fuses are hooked under these clips, the form of which retains them in place until the cap is pressed into the base, when the clips are flattened against the fuses, making perfect contact. The cap is then twisted sharply in the base until it engages two contact catches, by which the cap is held in position, and ample contact is secured by compression of the spring clips, which force the cap against the contact catches. It is therefore not necessary to loosen any screws, and no tools whatever are required, in re-



Emerson Ceiling Cut-Out.

placing a fuse. By an ingenious provision, which is simplicity itself, it is rendered impossible for the cap to shake loose, however great may be the vibrations to which it is subjected, a matter of considerable importance in some installations, as in factories and mills.

Proposed Electric Railway between Vienna and Budapest.

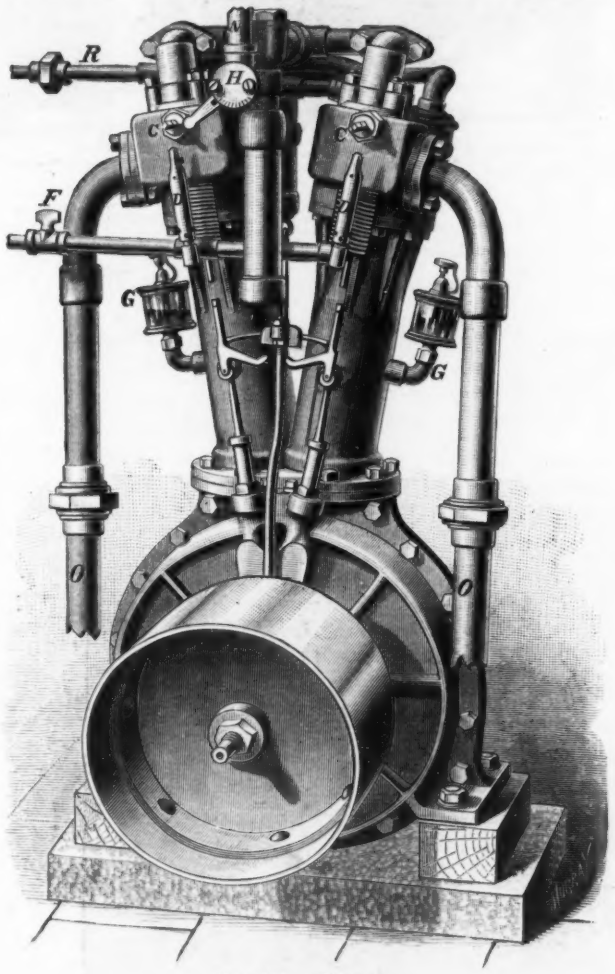
It is announced, says the Vienna correspondent of the London *Times*, that a company is about to be started, with a capital of 38,000,000 florins, for constructing an electrical railway between Vienna and Budapest. The distance of 250 kilometres (156 miles) is to be accomplished in two hours and a half by trains comprising only first-class carriages. The price of the return ticket is to be 9 florins 80 kreutzers, about $4.50. As it now takes four and one-half hours to travel between the Austrian and Hungarian capitals in an express train, the saving of time promised by the new company is a boon that will seem to many more tantalizing than attainable.

The Daimler Gas and Petroleum Motor.

Some time ago a one horse power motor of this company's make attached to a dynamo, which was driven at 500 revolutions per minute, was illustrated in the columns of The Electrical World. A new and improved type of

Emerson Ceiling Cut-Out.

this motor and of larger capacity is shown in the accompanying illustration. It is a two horse power motor and occupies a floor space of 16 feet × 6 inches and is 3 feet 2 inches in height; its weight is 300 pounds, and the normal speed five to six hundred revolutions per minute. The driving pulley, which is shown in the front of the cut, is 10 inches in diameter and has a seven inch face. The small floor space which it occupies makes it very suitable for the driving of small dynamos in locations where a larger engine could not be used on account of the limited space. It is operated with ordinary gas, or with petroleum, as desired, and requires a very small amount of attention while in operation. It is claimed that it can be made ready to start in less than one minute.

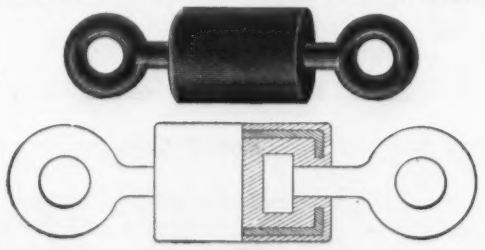


Daimler Motor.

Motors of this type are manufactured by the Daimler Motor Company, at Steinway, on Long Island, and are coming into quite extensive use for the driving of dynamos, and also for the operation of small pleasure boats. The machines are built in one, two and four horse power sizes. In Stuttgart, Germany, a street car is operated by one of these motors of 10 h. p. capacity, and a similar motor is now being constructed at the company's factory in Steinway for street railway purposes.

Chase Strain Insulator.

In the accompanying cuts both internal and external views are shown of the Chase strain insulator handled by



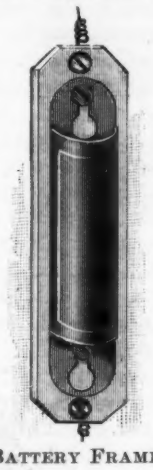
Line Insulator.

the Electrical Supply Company, of Chicago. It is comparatively small, but is designed especially for strength and high insulation. The insulating material, which is hard rubber, is molded in a solid mass about the interior plates. The section of rubber between the plates is large, as will be seen in the cut, and the insulating properties of the device are correspondingly great. The pattern is neat and the insulator does not attract attention on the line on account of bulkiness.

The Simplex Battery Frame.

This simple but convenient arrangement, made by the Nassau Electrical Company, of 19 Park place, this city, consists of a capsule battery, held in position between two spring contacts in a small black walnut frame, and protected by a removable metal guard. The frame is supplied, as shown in the accompanying cut, with wires attached to the contact points, and is ready to be placed in any electrical circuit.

When the battery is exhausted the guard is removed and a fresh capsule substituted, the whole operation not occupying half a minute, and requiring no electrical skill. For door bells, burglar alarms, and all other purposes where a simple and inexpensive method of using the well-known



Battery Frame.

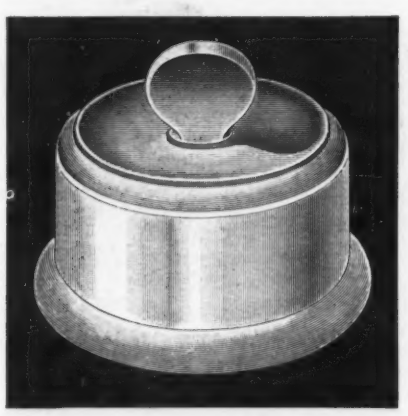
Nassau capsule battery is required, the Simplex battery frame will be found to be of very great service. The size of the frame is eight and one-half by one and three-quarter inches.

Meeting of the National Electric Light Association.

Mr. C. H. Barney, chairman of the Committee on Exhibits, announces that all parties desirous of exhibiting in the hall secured by the National Electric Light Association at Providence, R. I., on Feb. 17, 18 and 19 next, must send in their applications at once, as the allotment of space will soon begin. The applications already sent in aggregate nearly all the available space in the hall, and it may be necessary to cut down the applications *pro rata*.

The China Switch.

The accompanying illustration shows one of the ordinary forms of switches for incandescent circuits. It is made of china and is put upon the market by H. T. Paiste, of Philadelphia, the handle, cover and base being made of what is known as English ivory china. The switch is intended for fine residence installations, and is made in various neat and artistic styles. It is furnished in all colors, so that it may be made to harmonize with all kinds of wall paper, or any variety of interior decoration. One style with dull gold finish is said to be particularly attractive. These switches are imported by Mr. Paiste, and one of the noticeable features is that the cap screws on the base through a



China Switch.

thread cut in the china. Mr. Paiste claims for these switches that they will always present a fine appearance, as the china cover will not tarnish.

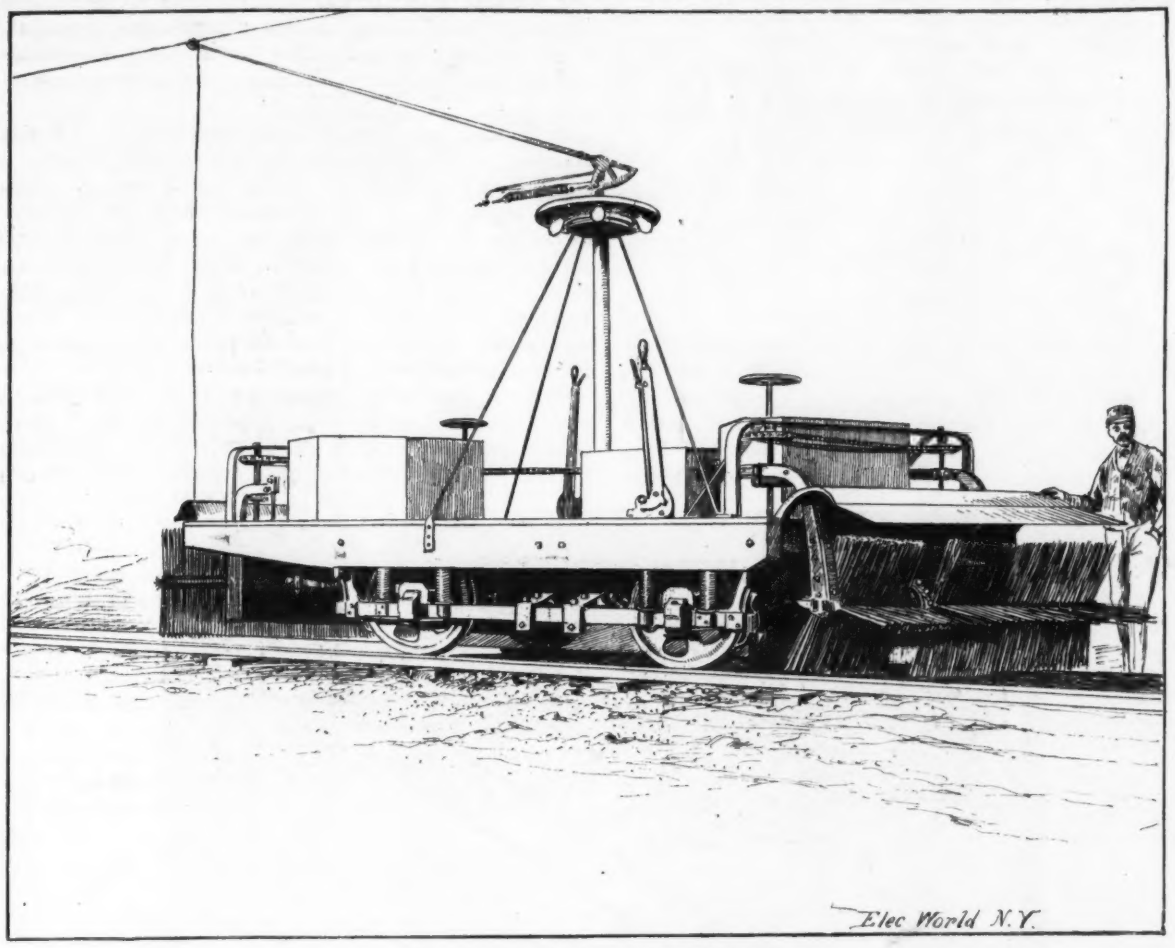
An Electric Snow Sweeper.

In the accompanying cut is illustrated a track sweeper or cleaner, designed by W. R. McLain, master mechanic of the Des Moines Street Railway Company, Des Moines, Iowa. Its various parts are so arranged that the running gear and propelling motors may be utilized for the transportation of passengers during the summer season and for a sweeper in the winter. The main object had in view was to overcome the difficulty due to the defective transmission of the motive power whenever the rotary brushes or track sweepers were necessarily raised or lowered in the operation of the machine, and to afford ready and convenient means for accomplishing this part of the operation.

Two 15 h. p. Thomson-Houston motors are mounted upon a truck of ordinary construction in the usual manner, being geared with the axles of the traction wheels and

regulated by a rheostat operated from either end of the machine. The platform of the car is rhomboidal in form, so that the two rotary sweepers located at each end of the machine and placed obliquely to the track may be raised to a point even with or slightly above the edge of the platform if desired.

Upon the platform are secured two 15 h. p. Thomson-Houston motors which operate their respective brushes independently, each being regulated by a separate rheostat. The axial shafts of these motors are geared with their countershafts in the usual manner, the only change in the form of gearing being in the substitution of sprocket wheels, belted with sprocket wheels on the axles of the sweeping brushes, for the toothed pinion wheel ordinarily gearing with the toothed wheels of the car axles.



AN ELECTRIC SNOW SWEEPER.

The sweeping brushes are of steel wire formed in four sections, bound together, the sets of steel wire projecting radially at right angles relative to each other. The device for raising and lowering the sweeping brushes consists of two screw-threaded vertical shafts located on each side of the platform, one of which is provided with a hand wheel, and each having a sprocket wheel, about which a sprocket chain passes, so that both of the shafts may be operated simultaneously from one point.

These horizontal levers being pivoted on a line with the countershaft carrying the driving sprocket wheels permit the raising and lowering of the sweeping brush without in any wise slackening the sprocket chain about the sprocket wheel on the countershaft and the sprocket wheel of the brush, thus always preserving the transmitting chain taut whatever may be the position of the brush.

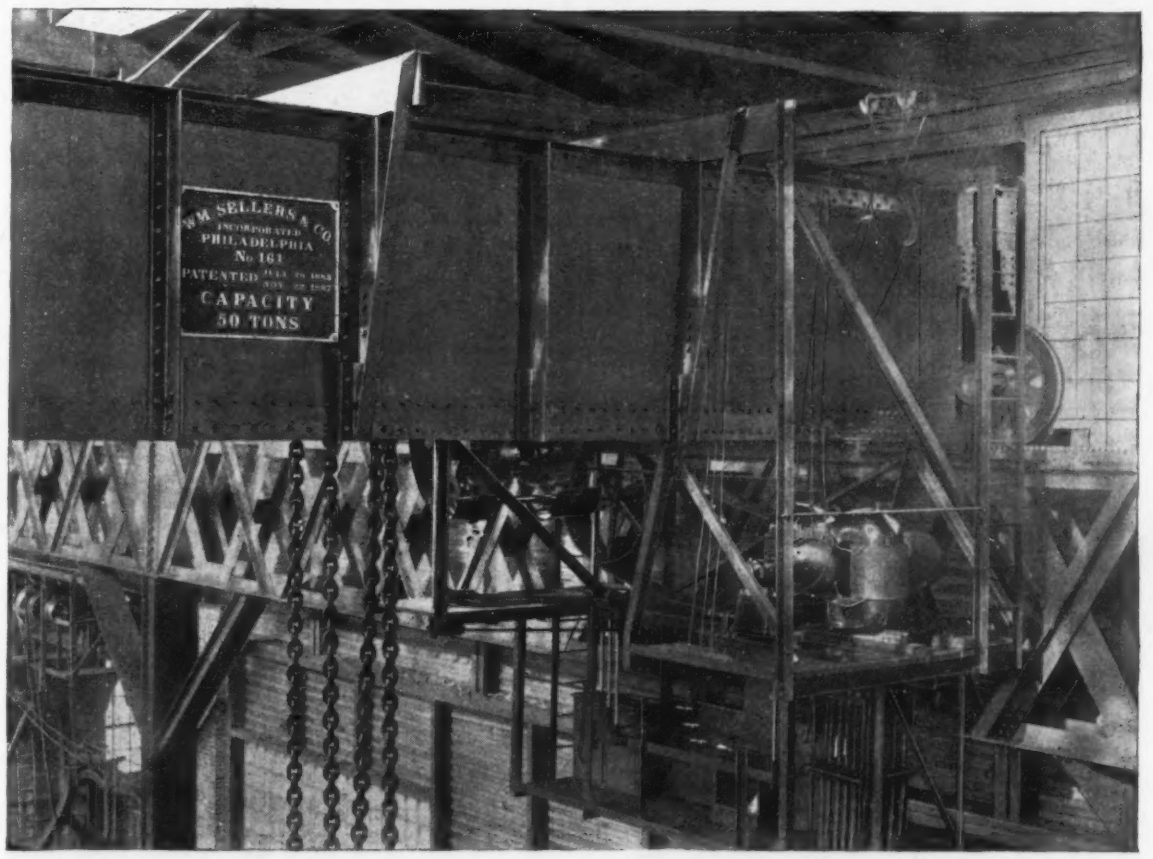
From the centre of the platform a vertical mast rises to which the trolley pole is pivoted, a cluster of lamps being disposed in a circle at its upper end as shown in the accompanying illustration.

Two horizontal levers are pivoted on a line with the countershaft carrying the driving sprocket wheel, threaded wrought iron blocks being provided, located under each lever through which the vertical shafts pass. These levers extending forward are bent downwardly over the edge of the platform and constitute the pivots of the brush shaft.

Electric Traveling Cranes in Philadelphia.

BY W. A. STADELMAN.

About one year ago Messrs. Wm. Sellers & Co., the large and widely known machine tool manufacturers of Philadelphia, began experimenting in the application of electric motors to the operation of their overhead high-speed traveling cranes. Their first attempt was with a 30-ton crane in their own works. This crane was equipped with one 15 h. p. Sprague automatic motor mounted on the cab of the crane, and belted with a linked leather belt to the driving machinery. Reversing clutches operated by levers were used to control the speed and direction of the various movements. The current is taken to the motor from a silicon bronze double overhead system by a Wheeler trolley. The entire plant has been successful from the start, having given no trouble of any kind and being in daily operation. So successful, in fact, was this crane that Messrs. Wm. Sellers & Co. were soon called upon to place electrically actuated cranes in a number of large shops. Among their installations were two cranes for the Pennsylvania Railroad Altoona shops, each equipped with a Sprague motor; one for the Schenectady Locomotive Works, Schenectady, N. Y.; one for Robert Poole Sons Company, of Baltimore, Md., and one for the Wenstrom Consolidated Dynamo and Motor Company, of Baltimore, Md. These last three cranes are each equipped with a large Wenstrom shunt-wound automatic motor and Wheeler trolleys, and in all of the installations here referred to the electrical construction work was done by the Equitable Engineering and Construction Company, of Philadelphia. But by far the most important installation of this description is that which the Messrs. Wm. Sellers & Co. have just finished for the Southwark Foundry and Machine Company and the Baldwin Locomotive Works, Philadelphia, Pa., the Baldwin plant being the largest traveling crane plant in the world.



OVERHEAD CRANE OPERATED BY AN ELECTRIC MOTOR.

In the Southwark plant there are two Sellers high speed cranes, side by side, in the erecting shop, each having its own runway of about 400 feet throughout the entire length of the shop. The lifting capacity of each crane is 50 tons, and each is equipped with a 35 h. p. Sprague automatic motor, belted to the machinery with a linked leather belt. A Wheeler double trolley running on an overhead silicon bronze line takes the current to the motor on the crane. Current is furnished by an Edison 60,000 watt dynamo, and at an electromotive force of 220 volts. Each line is fed at the central point from the feeders through a switch, so that either line could be made dead if necessary.

The cranes themselves are the standard machines of Messrs. Wm. Sellers & Co., and consist generally of two plate girders securely connected together at the ends and across the top, leaving the bottom clear for the operation of the lifting mechanism. The bridge of the crane travels laterally through the shop on four double flange wheels running on a very heavy steel rail, and is propelled by a spur gear engaging in a cast iron rack at either end of the bridge. The entire lifting mechanism is carried within the bridge of the crane. Before the introduction of the electric motor the power was conveyed to these cranes through a square shaft running the entire length of the runway; but the application of the electric motor does away entirely with this shafting, which is objectionable for many reasons, long lengths of it frequently getting out of line and giving great trouble.

In all the Sellers cranes, so far built, but one motor is used. The various speeds and movements are given to the different parts by reversing friction clutches and speed gearing. The operator sits facing his work, and has all the levers before him. The bridge travels laterally along the runway at a speed of 200 feet per minute with the greatest ease.

An electrically operated crane is decidedly more economical than a similar crane propelled by square shafting, for the reason that the square shafting which runs all the time is a dead load in itself, while the electric motor when running idle consumes but little power in comparison.

Cyrus W. Field and His English Associates.

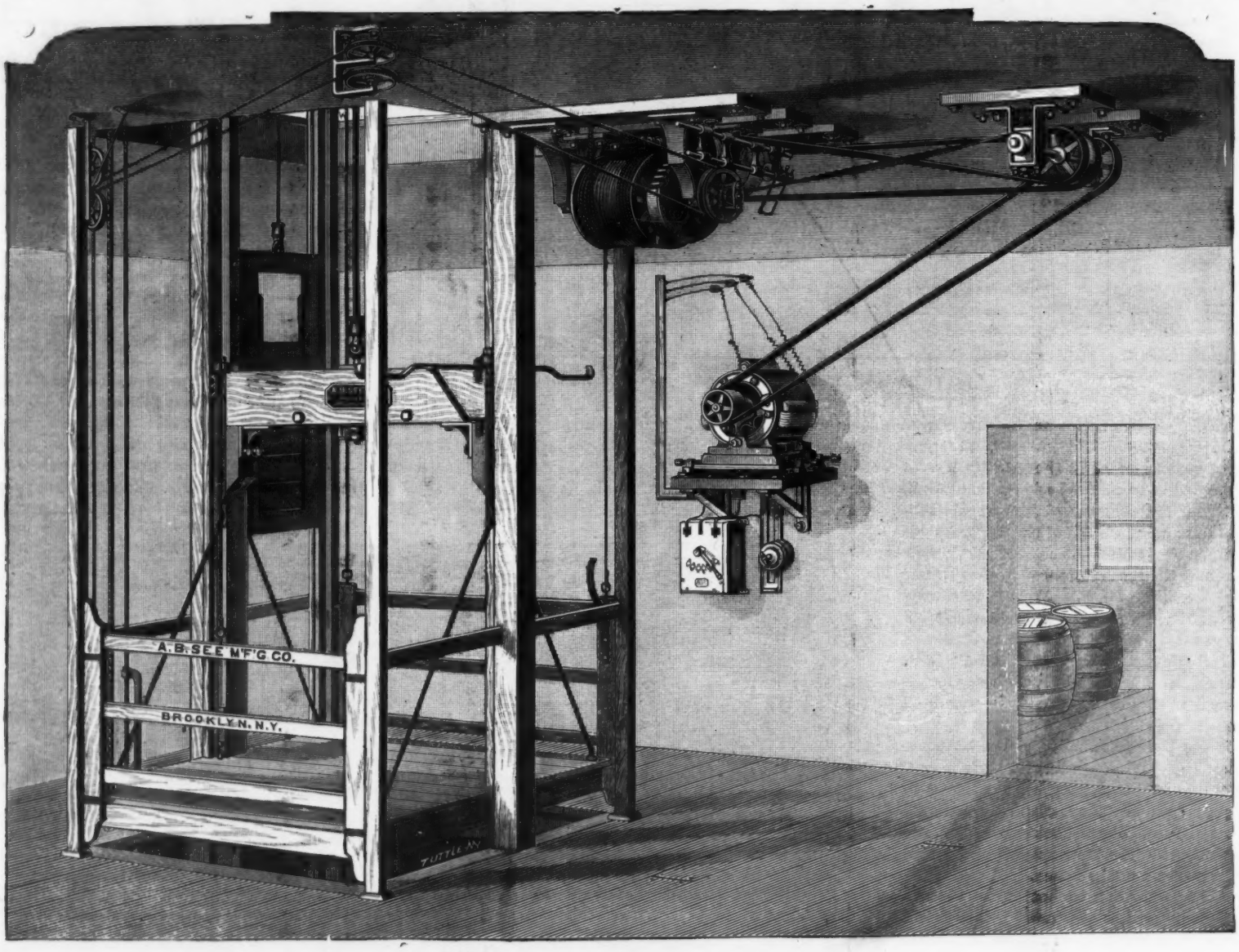
When Mr. and Mrs. Cyrus W. Field celebrated their golden wedding on Dec. 2 a congratulatory address was cabled to them from many friends in London. A magnificent vellum album containing the autographs of the senders of the address, as well as the original copy of it, has been received by Mr. Field. It contains the signatures of the Duke of Argyle, Canon Farrar, Lord Monck, W. E. Gladstone, the Marquis Tweeddale, Sir H. D. Gooch, Catherine Gladstone, Jane Cobden, Admiral Sir Richard C. Mayne, Lord Stanley, of Alderley; John Chatterton, Constance Wilde, Oscar Wilde, Gen. Sir William McMurdo, and many others. The reply of Mr. Field to the address was as follows:

"Permit me to thank you for your congratulations to my wife and myself on the occasion of our golden wedding. It is very gratifying to know that our friends in the United Kingdom, whose many kindnesses in former years we can never forget, retain for us such a cordial remembrance. As you refer to the part I had in promoting telegraphic communication across the Atlantic, I may say that it has been the great satisfaction of my life to have done something to bring our two countries together. The ocean no longer separates us.

"Every hour of the day and night messages are passing to and fro between England and America. This constant intercourse brings us into the relation of neighbors. In our daily conversations we seem to hear your voices under the sea, which, as they speak in the tongue wherein we were born, we recognize as the voices of our kindred, those of the same blood, to whom we are bound by the ties of nature itself. To have had a part in this work of peace and good will is indeed a grateful recollection. May this brotherhood of nations be continued when we are gone, and grow stronger from generation to generation."

A Low Speed Motor for Elevator Work.

A few weeks ago we described in our columns the construction of Mr. Perret's multipolar low speed motors. The accompanying illustration shows one of these motors of 10 h. p. capacity operating a freight elevator at the warehouse of Leavy & Britton Brewing Company on Front street, Brooklyn. The elevator apparatus was manufactured by the A. B. See Manufacturing Company, of Brooklyn, and the motor is supplied with a current at a pressure of 220 volts from the underground circuit of the Edison Illuminating Company. The motor is equipped with self-oiling bearings and self-feeding carbon brushes which require practically no adjustment or attention; by this means the care required by the apparatus is reduced to a minimum, as the most inexperienced person can successfully operate the motor without any of the difficulties sometimes experienced with copper brushes, the setting of which is occasionally a troublesome affair. Motors equipped with these carbon brushes of Mr. Perret's invention, it is said, have run for nearly a year without any attention to either the commutator or brushes; the total amount of wear on the brushes in that time being only one-sixteenth of an inch, while there was no noticeable wear whatever upon the commutator. As will be seen in the illustration, the space occupied by the motor and its accompanying accessories is very small indeed; a point which those having an installation of this kind in charge have not been slow to appreciate. It may be mentioned that a 20 h. p. motor of this same type has just been placed in the Hamilton Club House of Brooklyn to drive a pump for a hydraulic passenger elevator.



PERRET MULTIPOLAR MOTOR RUNNING A FREIGHT ELEVATOR.

Telegraphic Transmission on Long Subterranean Lines Without the Use of Relays.*

As is generally known, telegraphic transmission is not so easily carried out on long subterranean as on aerial circuits. On underground circuits of less than 190 miles retardation phenomena are scarcely noticeable, but for greater distances than this, electrostatic effects become increasingly troublesome, and since the underground telegraph system of Germany has assumed large proportions, the authorities have tried to annul these pernicious phenomena in a variety of ways. For instance, a short path to earth has been offered after each signal at either end of the line to the discharge current; alternate current working has been attempted, and condensers have been used to neutralize the charge of the cable by one of the opposite sign from the condensers. None of these methods, some of which involved the addition to the ordinary instruments of costly and cumbersome apparatus, fulfilled the desideratum of enabling messages to be transmitted as quickly and clearly as on overhead circuits of equal length. The most efficacious method was considered to be the employment of relays at every 100 or 150 miles, and even then the rate of transmission was considerably less than on overhead lines. Recently an apparatus was devised by Delany, of New York, which, although intended primarily for use on long submarine cables, seemed equally suitable for subterranean work. By

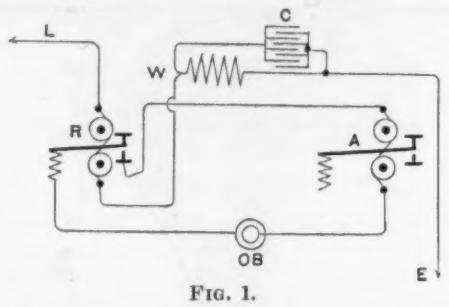


FIG. 1.

means of the Delany key we can, it is true, send Morse signals much quicker than has hitherto been possible, but it necessitates the employment of complicated apparatus, liable to get out of order. The engineering staff of the German Post Office, therefore, who had been ordered to investigate the practical value of the Delany device, set to work to try and obtain the same resu in a simpler manner and without altering the instrument at present in use. Now, augmentation of the speed of transmission depends on realizing three conditions : (1) Decrease of battery resistance ; (2) acceleration of the discharge of the cable ; (3) compensating the self-induction

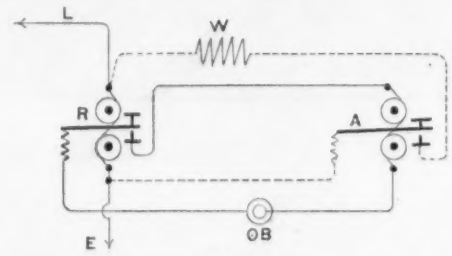


FIG. 2.

of the receiving apparatus. It is easy to fulfill the first condition, either by arranging the cells in parallel or by using secondary cells. The disturbance produced by self-induction is connected with the effect of the cable discharge. The tongue of a sensitively adjusted relay should fall and close the local circuit as soon as the first part of the current reaches the receiving end ; but the release of the tongue is retarded by the discharge current, and this retardation is prolonged by self-induction. To neutralize these effects recourse may be had to an old device proposed by Maxwell.

In this arrangement a resistance W, in shunt with a condenser C, is placed between the receiving relay R and earth E (Fig. 2). The resistance must bear a certain definite relation to the capacity of the condenser, which relation has to be determined by experiment. The installation of a condenser in the first place permits of a more rapid rise of current at the receiving end, since it fulfills during the first instants of charging the functions of an earth. The attraction of the tongue of the relay is thus favored. Moreover, the discharge current of the condenser and the "extra current" from the line are mutually destructive, and the disappearance of the magnetism is thus accelerated.

In the first experiment with this arrangement the Berlin-Hamburg cables were looped, forming a circuit of 272 miles and having a resistance of 5,151ω and a capacity of 150 microfarads. In the second experiment the Berlin-Frankfort cables were looped: length 350 miles, resistance 4,279 ohms, capacity 120 microfarads. The resistance of W was 9,430 ohms, and the capacity of C 20 microfarads. Fifty Tudor accumulators were employed, reinforced by 40 primary cells. In the first case 300 primary cells arranged 100 in series and three in parallel were used.

So far as speed of transmission was concerned these experiments were satisfactory. Representing the ordinary rate of transmission of Morse signals, without translation by 100, the speed of transmission when a shunted condenser was used was 131, or nearly 30 per cent. greater. It must, however, be remembered that the ratio of W to C has to be determined in each individual case, so that the use of this method does not tend to certainty of transmission, and it may derange the working of the line. Attempts were, therefore, next made to attain the same increase of speed without condenser, and this result was finally attained by the very simple arrangement shown in Fig. 2.

In shunt with coils of the relay a variable resistance W is placed, and this resistance only comes into play when the "inker" operates. The effect of this arrangement is to accelerate the discharge of the line. When the current wave at R has attained sufficient strength to work the relay, the Morse recorder A operates. The remainder of the wave then divides, some going to E via W. The current in R is of course diminished the smaller W is made, and the release of the tongue is thus hastened. The tongue must not, however, be released before a proper Morse signal has been recorded, and the resistance of W must therefore, be properly proportioned to that of R. It has been found useful to prolong the effect of the shunt circuit, which can be effected by fixing a light spring to the lower end of the "inker" lever so as to hasten the closing of the shunt circuit. If this circuit is of too low resistance the tongue of the relay is released too soon, while if the resistance of W is properly adjusted, the current flowing in R, together with the "extra current," act long enough to allow a signal to be produced.

*Abstract of a paper read by Herr Grawinkel, chief engineer to the German Post Office, before the Berlin Electro-technical Society.

Favorable results have been obtained with this arrangement in transmitting Morse signals without translating devices over a subterranean line connecting Berlin and Frankfort. The relative speeds were: Ordinary Morse, 100; condenser and resistance method, 131; arrangement shown in Fig. 2, 145. Further tests of this method on underground lines have shown that Morse signals can be transmitted at the same rate as on overhead circuits up to distances of more than 375 miles, and that on longer an increase of speed of 30 per cent. is obtainable, when compared to the old device of fixing relays at every hundred miles. When a line is more than 625 miles (1,000 kilometres) long, it is advisable to instal midway a relay on the shunt principle. One circumstance which contributes in a great measure to acceleration of transmission is that it is no longer necessary to employ such sensitive relays as formerly; sticking of the relay tongue and the consequent blending of signals is thus avoided. Readjustment of the relay is also less frequently needed. Let us hope that this new device may be equally applicable to the transmission of Hughes signals on underground circuits.

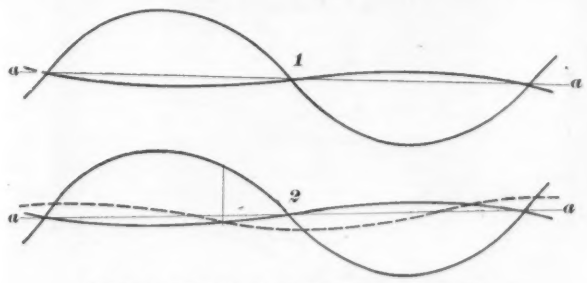
Arc Currents Stabled by the Regulator.

BY DANIEL HIGHAM.

As there is so little understood regarding the performance of regulators used in connection with arc currents, it will be necessary to give some attention to this phase of the subject before entering directly upon the new method of regulation to be brought out in this article.

In every circuit there are certain electromotive forces which will just sustain certain intensities of current. If these sustaining electromotive forces for the different intensities of current were represented by a set of curves, we would then have some clear understanding of the necessary performance of a regulator intended to work in that circuit. The sustaining electromotive force in an arc circuit necessary for the arcs alone is approximately shown in Fig. 1; the mean working intensity of current and the mean electromotive force for a fixed number of arcs being both represented in the diagram by the horizontal line *a a*. The heavy line curve shows a wave in the current intensity of about five per cent. variation, while the light line curve shows the electromotive force which would just sustain the intensity of current at any point in the wave. The rise in the curves toward the top of the diagram shows a rise of current or electromotive force, and the fall of the curves shows a fall in either of the same, as the case may be, the percentage of variation in the current intensity and the electromotive force being illustrated by the rise and fall given to the curves. The sustaining electromotive force in an incandescent circuit will rise and fall with the current; that is, to sustain an increase of current the electromotive force must be proportionately increased. The variation of current in an arc circuit, however, causes the resistance of the arcs to fall at every rise of current and rise at every fall of current. The extent of this rise and fall of resistance in the arcs is such that the sustaining electromotive force will fall when the current rises and rise when the current falls, as shown in the diagram.

Now if a regulation curve were inserted in this diagram we could see at a glance whether the wave in the current would be reduced or not. Knowing that a regulator—that is, the regulators now used in connection with continuous current arc dynamos—will not raise the electromotive force until the current falls below the working intensity, and not decrease the electromotive force until the current rises above the working intensity, a curve of the electromotive force can be approximately determined as it would



FIGS. 1 AND 2.—ARC CURRENT CURVES.

be produced by the wave of current shown in the diagram, allowing reasonably for loss of time in the movement of the regulator. The dash line curve in Fig. 2 shows a wave in the electromotive force about as it would be produced by a regulator in accordance with the above—that is, the regulating electromotive force is shown as starting to fall a short time after the current has passed above the mean or working intensity, and as starting to rise a short time after the current has passed below the mean intensity.

By a study of this performance in regulation it will be seen that the current wave *would not be reduced*, notwithstanding that the performance shown could only be accomplished by an exceedingly good working regulator, and with but very little interference from variations of intensity in the magnetic field of the dynamo. The reason is that the regulating electromotive force does not cross the sustaining electromotive force before the current wave starts to fall. As long as the regulating electromotive force is above the sustaining electromotive force the current will continue to rise, and not until it falls below the sustaining electromotive force will the current start to fall. The small ordinate in the diagram shows the point where the current would start to fall, which, it will be seen, is far beyond the starting point of fall in the current wave intended to be reduced. Such a performance in regulation would cause the current wave to increase at every oscillation until finally the current would alternately be raised with a great rush and interrupted completely. This phenomenon, which is nothing more than an unstabled current, has been witnessed by a few designers of arc dynamos. It comes from trying to make too efficient a design of dynamo.

In Fig. 3 the sustaining electromotive force curve is drawn so that the regulating electromotive force curve

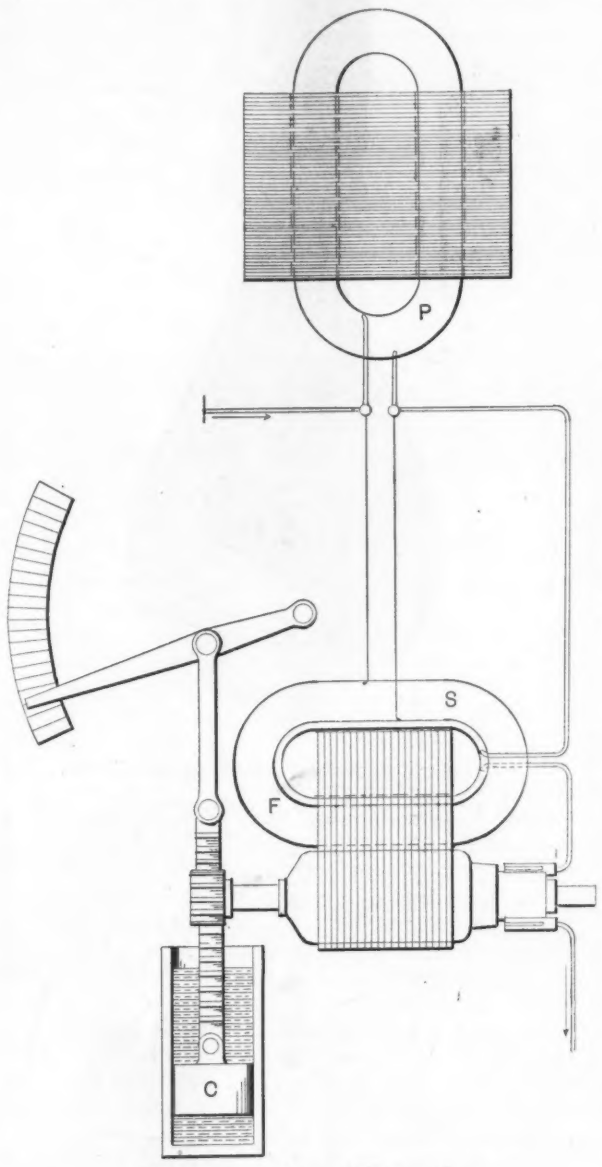


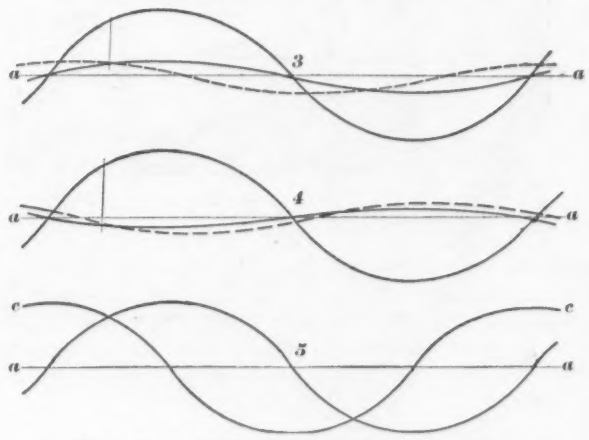
FIG. 6.—ARC LIGHT REGULATOR.

crosses it before the start of fall in the current wave is reached. This is the performance in regulation as it appears in all arc current regulators now in use to obtain a stabled current. It is accomplished, although originally unintentionally, by designing the dynamo to have a large amount of wire windings in order that there shall be sufficient ohmic resistance in the circuit to cause the sustaining electromotive force to rise and fall in the direction of the current to about the extent shown in the diagram. In this way stability of current is obtained, but, as will be understood, at a sacrifice of the efficiency of the dynamo, as well as making the cost in manufacture of the dynamo much more than would otherwise be necessary.

The effect of self-induction in the circuit upon the electromotive force have been left out of the diagram for the reason that the regulating electromotive force will cross the sustaining electromotive force at precisely the same point in the current wave whether it be considered or not, its effect on the regulating and sustaining electromotive force being simultaneously and the same. The regulating electromotive force as effected by variations of intensity in the magnetic field of the dynamo also need not be considered, for the reason that the magnets in all arc dynamos are about saturated—even when the method of regulation consists of varying the magnetic intensity of the field, the magnets are about saturated when making at full load—so that the intensity of the field will remain constant to the current wave, especially if there is chance for Foucault currents in the core.

The above illustration of the performance of regulators now in use will be probably sufficient to allow of a new performance in regulation to be introduced. As pointed out above, the conditions of stability in regulation are dependent upon "the sustaining electromotive force being crossed by the regulating electromotive force before the point of start to fall or rise in the current wave is reached." Now this has always been accomplished by the use of a dynamo having a large amount of otherwise unnecessary windings to bring the sustaining electromotive force about, as shown in Fig. 3, but the conditions of stability can be accomplished by keeping the sustaining electromotive force, say for illustration as shown in Fig. 1, and changing the regulating electromotive force so as to cross the sustaining electromotive force before the point of start to fall or rise in the current wave is reached. This performance in regulation, which is the real subject of this article, is shown in Fig. 4. It is accomplished by raising and lowering the regulating electromotive force at the points of start to fall and rise respectively in the current wave, instead of waiting for the current to fall below or rise above the mean intensity, as is the case with the methods of regulation now in use, or, what is the same thing, by making the wave in the regulating electromotive force ahead in phase by one-quarter wave length over that obtained in the performance of regulators now in use. There are several forms of devices to carry this out, but only one of the forms dependent upon the use of a secondary current responsive to wave variations in the main or working circuit, by one-quarter wave length ahead in phase, will be illustrated in this article. Such a device or regulator is diagramatically shown in Fig. 6.

Without entering into any commercial detail requirements—for these are intended to form the subject of another article—a brief description of the working of the regulator shown in the diagram will be given. If a voltmeter were connected to the terminals of a coil of low resistance and of very high self-induction, and were the current traversing the coil waved at about the frequency a regulator would wave a current, we would find that the highest potential would be at the sharpest rise and fall in the current, and that the potential would be zero at the points of start to rise and fall in the current wave, as shown in Fig. 5, the curve *c c* being the wave of potential, the rise of current producing opposite potential of course to that produced by the fall. It should be mentioned that, in order to obtain this difference in phase of the current traversing the coil and the potential at its terminals, it will be necessary to offer as much resistance as possible to Foucault currents in the magnetic circuit surrounding the coil and to shunt as small a current from the coil as possible. Now, if in place of the voltmeter coil a coil say, for clearness of illustration, of nearly the same resistance, but of larger wire and a larger number of turns be wound on the field magnet core of a small motor, the polarity of the magnet would be reversed at the points of start to fall and rise in the current wave. Therefore, if the coil of the motor armature were traversed by a continuous current the armature would reverse its direction of movement in rotation at these points in the current wave. In this way the regulating electromotive force, if controlled by the movement of the motor armature, can be waved ahead in phase one-quarter wave length over that obtained in the performance of regulators now used in connection with arc currents. Referring to the diagram, Fig. 6, *P* is the low resistance coil and *S* the high resistance coil on the core of the motor magnet. To maintain a constant intensity of current in the working circuit, however, it will be necessary to have on the magnet core of the motor, together with the fine wire coil *S*, a small thick wire coil *F* connected in the working circuit. The magnetic effect of this coil should just be sufficient to balance the weight *G* and connecting rod, shown in the diagram, when the current is at the desired or working intensity. The fine wire coil *S* is practically short-circuited by the coil *P* when the current is steady, it should be mentioned, so that nothing but the current traversing the coil *F* need be considered. As the coil *F* will act as an ordi-



FIGS. 3, 4 AND 5.—ARC CURRENT CURVES.

nary regulator its magnetic effect as compared to the fine wire coil *S* should be small.

Although the effect of the coil *F* may be small, it will so modify the effect of the coil *S* as to make it a little later or earlier in the movement or reversal of the motor armature, accordingly as the current may be above or below the working intensity, as will be understood. When the resistance of the fine wire coil *S* is such that an accidental break in the working circuit would not burn it out, a five per cent. variation of current in the working circuit would produce a current intensity in the coil *S* of about 2,500 ampères per square inch, thus making the inertia and friction of the regulator a small factor in the magnetic effect of the coil *S*. The above difference of phase in currents to obtain this new performance in regulation can also be accomplished by a specially designed transformer, but this design will not be entered into in this article.

In illustrating this new performance in regulation as compared to regulators now in use, it has been the endeavor to be as brief as possible. For this reason the curve

in the diagrams have been drawn as plain wave curves having no short falls or rises, which would naturally arise from the many actions inherent to an arc circuit. The advantages gained by this method of stabling arc currents by the regulator will be apparent. Instead of resorting to a costly and inefficient design of arc dynamos to obtain this result, it is accomplished by the performance in regulation, thus allowing arc dynamos to be made as high in efficiency as the incandescent dynamcs and at a great reduction in cost of manufacture.

An Improved Glass Insulator Knob.

In the accompanying illustration is shown a glass insulator which it is claimed possesses a number of features which are considered improvements upon some of the old types of glass insulator. As will be seen, the groove for holding the wire is V-shaped, so that all sizes of wire can be wrapped about it and held with equal firmness. The insu-

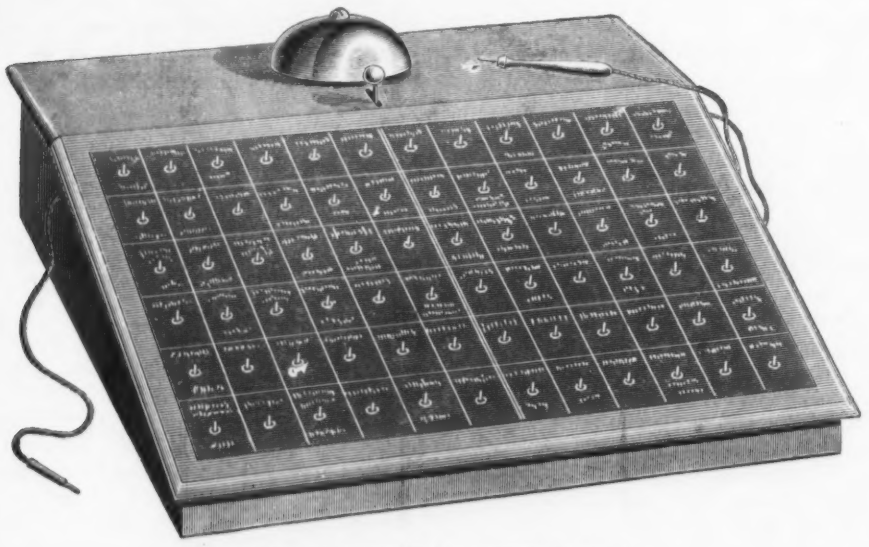
The "Universal" Glass Insulator.

lator is made both in clear and opal glass, which is especially prepared. It is placed upon the market by W. A. Giles, of Pittsburgh, Pa.

The Electric Automatic Instructor.

The applications of electricity to the operation of toys and various devices for the amusement and instruction of young people are becoming quite numerous, but it is seldom that one meets with an apparatus of this kind so unique as that which is illustrated on this page. The electric automatic instructor consists essentially of an electric bell, a single cell of dry battery, a pair of terminals attached to flexible cords and 36 electric circuits, through any one of which, when contact is made at its extremities, the current from the battery will flow, and being thus connected through the circuit of the electric bell it will ring.

The terminals of the 36 circuits are arranged in six rows of 12 each upon the front of the desk-like case of the apparatus, and are simply pins which project through the cover of the case; the wires connecting these points are concealed on the under side of the cover. Cords are provided for 72 holes, pierced through each of them in such a way that they fit exactly over the terminals of the



THE ELECTRICAL INSTRUCTOR.

circuits. Around each of the 36 terminals on the left hand side are the printed questions and around each of the 36 terminals on the right are printed the answers. These 36 answers correspond to the 36 questions printed upon the same card, although the answers are not arranged in the same order as are the questions.

Now it will be seen that all that it is necessary to do in order to find the answer to any question is to connect the key attached to the left hand flexible cord on the pin that appears in the centre of the question to be asked, then taking the terminal attached to the right hand flexible cord a ring of the bell will be produced wherever the terminal corresponding to the answer upon the right hand side is touched. Twenty-four cards are provided with the apparatus containing questions and answers upon a variety of subjects, such as arithmetical, geographical, statistical and historical information. The well-known Crosby dry battery is used in this piece of apparatus. The apparatus itself is manufactured and placed upon the market by the Knapp Electric and Novelty Company at 280 Broadway, this city. The instructor measures about 12 × 18, and is not more than four inches high, and furnishes a decidedly attractive method of giving amusement to children and young people, as well as instruction upon the various subjects which are arranged upon the cards.

A Curious Deposit of Carbon on an Incandescent Lamp Globe.

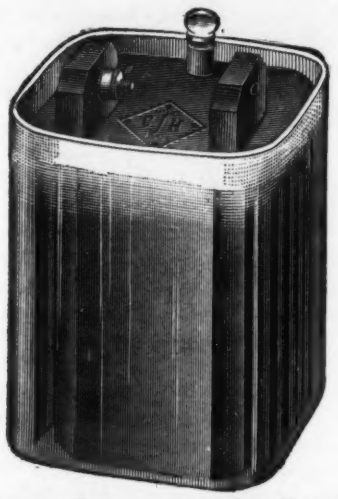
Every one has noticed a deposit of carbon which ordinarily takes place in an incandescent lamp that has been

Carbon Deposit on Incandescent Lamp.

burning for some time, and this deposit increases in thickness with the life of the lamp, and under ordinary circumstances is evenly deposited over the interior surface of the globe. Occasionally, however, a peculiar distribution of the carbon occurs. The accompanying illustration shows the appearance of a deposit upon a 50 c. p. incandescent lamp, a photograph of which was kindly furnished us by Messrs. Wright & Starr, of Philadelphia. The lamp was placed upon a portable stand, the shade having a metal support, and was burned upon a circuit having a pressure of 110 volts. After burning about 500 hours the peculiar deposit, which is well shown in the cut, was noticed, and, as will be seen instead of being distributed evenly over the surface, as is generally the case, took a very unusual form; there was, however, a slight deposit over the entire surface. The unusual deposit occurred in four positions, all of these being of similar form and of about the same density.

The Dissociation of Carbon Dioxide Gas by the Electric Spark.

An interesting paper, says *Nature*, is communicated by Prof. von Hofmann to the current number of the *Berichte* upon the dissociation of carbon dioxide gas into carbon monoxide and oxygen by means of the electric spark. Dalton and Henry long ago showed that carbon dioxide, although formed by exploding a mixture of two volumes of carbon monoxide with one volume of oxygen by the passage of an electric spark, is again partially decomposed into carbon monoxide and oxygen by the continued passage of the spark. Prof. Hofmann has now determined the exact conditions under which the explosive recombination occurs. The most suitable distance apart of the platinum terminals appears to be between two and a half and three millimetres, and Professor Hofmann advises the use of adjustable terminals rather than the ordinary platinum wires fused into the side of the eudiometer. A Leyden jar in the circuit renders the occurrence of periodical explosions more certain. The spark should also pass at about a quarter of the height of the gas column instead of, as usual, near the top. The current itself, moreover, should not be too strong; that from two Bunsen cells and only a moderate sized Ruhmkorff coil yields the best results. It is also preferable to use a volume of carbon dioxide, previously dried over sulphuric acid, not exceeding ten cubic centimetres at a pressure of 650 to 700 millimetres. Under these new conditions the first explosion usually occurs in about 15 to 20 minutes. The second and succeeding explosions occur after shorter intervals than the first. This experiment is certainly one of the most interesting in all the range of dissociation phenomena.



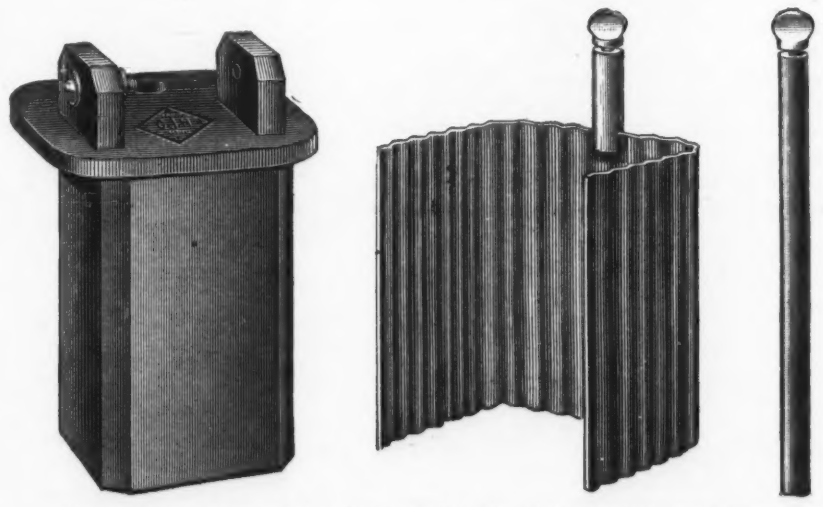
Complete Cell of Champion Battery.

Inspection of Wires at Lynn, Mass.

An ordinance establishing a municipal electrical committee was passed last week. The committee will have charge of the maintenance of all wires belonging to the city, and approve all bills incurred for their maintenance It will have charge also of all work done upon wires belonging to other persons or corporations, which is required to be done under the statutes, and wherever corporations or parties are required to reimburse the city for money expended by it in such work the committee shall take care that the same is collected. The city electrician is designated as the officer who shall perform the duties required.

A New Primary Battery.

A new battery put forward by Mr. C. J. Hirlimann, of 91 Greenwich street, N. Y., is known under the name of the "Champion" and is made both with the ordinary Leclanché rod zinc and also with a large service zinc, which is composed of corrugated sheet metal.



CARBON RESERVOIR AND ZINCS OF CHAMPION BATTERY.

In the first form the voltage and ampèreage do not differ materially from other sal ammoniac batteries in use, but it is claimed that in point of longevity it is far superior to the other types now upon the market. With respect to the Champion battery with corrugated zinc, especial stress is laid upon the low internal resistance which is obtained and the consequent large ampèreage, making it especially adapted to all uses where a large quantity of current for short periods of time is required.

According to a certified report from Prof. Geo. d'Infreville, formerly chief electrician of the Western Union Telegraph Company, the battery measures 1.4 volts E. M. F. and .17 of an ohm internal resistance. The illustrations will give a general idea of the character of the cell, which in the glass jar is square in form, in order to allow for greater quantity of water. The negative element consists of a carbon reservoir, charged with ingredients made up under a special formula of the inventor.

Electromagnetic Mechanisms.*

BY PROF. SILVANUS P. THOMPSON, D.SC., B.A.

INTRODUCTORY.

To the mechanical engineer the study of the electromagnet presents many interesting problems. By its means power transmitted electrically along a conducting wire produces a mechanical motion. The conditions of that motion constitute in one sense a purely mechanical problem, though the electric and magnetic conditions under which the power is supplied, and upon which the motion depends, belong to electrical science.

Consider at the outset in what an electromagnet consists. The magnetic portion of it usually comprises two parts, a fixed iron core, straight or bent, and a movable piece of iron called the armature, the two being themselves portions of a magnetic circuit. The electric portion of it is a coil of insulated copper wire, usually encircling the iron core with numerous convolutions. When an electric current is switched on in the copper wire it produces upon the iron core a magnetic action. The magnetizing force of the coil is strictly proportio nal to the electric current that is flowing in the wire and to the number of convolutions which that wire makes around the magnetic circuit. But the amount of magnetism induced in the core is not simply proportional to the magnetizing force alone; it depends also upon the perfection or otherwise of the magnetic circuit. If the magnetic circuit constituted by the iron core and its armature and the intervening air-gaps is of insufficient cross-section, or of poor quality of material, or of inordinate length, or if the gaps in it are considerable, then its reluctance to magnetization may be so great that very little magnetism will be induced in it, even by the application of considerable magnetizing power. The principle of the magnetic circuit, about which much must presently be said, is of the first importance as a key to the behavior of electromagnets. A second guiding principle is to be found in the tendency which a magnetic circuit exhibits to perfect itself. That is to say, a magnetic circuit when subjected to a magnetic force tends, if so arranged that any part of it can move, to so alter its configuration as to become as compact as possible. If the armature, for example, is movable, and placed at some little distance away from the ends of the core or cores, it will be mechanically urged into greater proximity, so that core and armature may together constitute, as nearly as possible, a closed circuit of iron. In

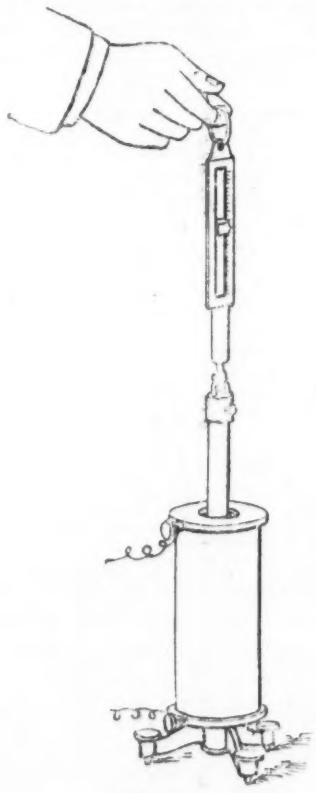


FIG. 1.

doing so the armature performs mechanical work. The action of the common horseshoe form of electromagnet in drawing up its armature, as in the ordinary sort of electric bell, is an elementary illustration of this principle.

A second form of electromagnet consists of a tubular coil of copper wire into the hollow of which a long iron plunger is drawn when the electric current flows around the coil. This coil and plunger species of electromagnet possesses several mechanical characteristics which distinguish it from the horseshoe form; but the principle of the magnetic circuit applies equally to both.

MODERN VIEWS OF MAGNETISM.

Now, in dealing with magnetic circuits, we must carefully cut ourselves off from those mediæval notions about magnetism which still haunt the text-books of physics, according to which magnetism is regarded as a sort of fluid (or fluids) distributed over the end-surfaces (or poles) of magnets. With the polar distribution of supposed magnetic fluids we have nothing to do. The alleged fluids are pure fictions; the existence of a polar surface is a pure accident. The most highly magnetized part of a magnet is usually that part which shows upon its surface not a trace of polar action. The particular form of iron core which can be more highly magnetized than any other, namely, an iron ring closed upon itself, has no magnetic poles. Magnetism is, in truth, an internal rather than an external phenomenon. It is possible to have a steel ring so magnetized that the magnetization shall be entirely internal; the magnetic lines flowing around wholly within the metal, and never coming up to the surface. Of course such a ring magnet is incapable of attracting iron filings or of perturbing a compass needle. The evidence that such a ring is magnetized internally is very simple. If cut or broken across, such a ring forthwith exhibits polar properties at the cut surface. A pole or polar region of a magnet is simply that part of the surface where the internal magnetic lines emerge into the air. Only such parts—the surfaces of gaps in the magnetic circuit—exhibit any such properties as those to which formerly the virtues of magnetic fluid were attributed.

The appropriate modern mode of regarding magnetic phenomena is to consider the various materials—iron, steel,

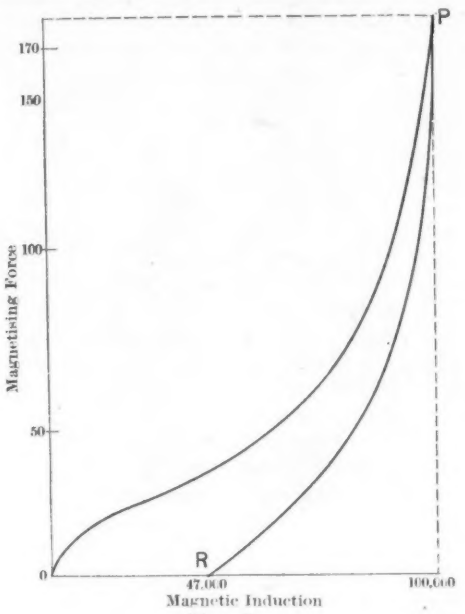


FIG. 2.

air and the rest—as being in various degrees *conductors of magnetic lines*, magnetic lines being stream lines in the medium, conventionally taken to represent by their number and direction the quantity and direction of the flux of internal magnetization. Soft annealed wrought iron is, for example, an excellent conductor of magnetic lines, being more permeable magnetically than any other known material. Magnetic permeability is a term to which a precise numerical notion has been attached, being the ratio between the magnetizing force and the resulting intensity of magnetic induction in the specimen. This mode of regarding the matter has resulted from the modern study of electromagnetic apparatus. The necessity of such ideas did not occur to the earlier workers in magnetism who were dealing exclusively with magnets made of steel or of loadstone permanently magnetized. They thought of poles acting from a point, as it were, attracting a piece of iron at a distance from it. We, on the other hand, have rather to think of stresses in the path of the magnetic lines. Wherever there is a gap in the magnetic circuit between iron and iron there is a magnetic stress urging the configuration so to change as to close up the gap. This stress urges the armature of the electromagnet toward the iron core. You may call this an attraction of the one by the other if you prefer that way of putting it. Only beware, for this attraction does not vary as the inverse square of the distance between iron and iron; it depends solely upon the intensity of the magnetic flux in the intervening medium being proportional to the square of that intensity. The space crossed by magnetic stream lines wherein such magnetic stresses are in action is known as a magnetic *field*.

INVENTION AND DEVELOPMENT OF THE ELECTROMAGNET.

Immediately following the discoveries in 1820 and 1821 by Oersted, Ampère and Arago of the magnetic properties of electric currents came, in 1825, the invention of the electromagnet by William Sturgeon, of Woolwich. The apparatus he first produced consisted of a bent iron rod, about 1 ft. long and ½ in. in diameter, varnished over and then coiled with a single spiral of stout uncovered copper wire of 18 convolutions. For the first time there was thus put into the hands of the electrician a magnet capable not only of being excited and discharged at will, but of being operated from a relatively great distance by means of the electric wire. Sturgeon constructed numerous electromagnets, some of the bent or horseshoe pattern, others with straight bars or rods of iron as cores. In those days, copper wire overspun with silk or cotton was unknown as an article of commerce, and gutta-percha coverings were as yet undiscovered. Sturgeon was content to use uncovered copper wire of considerable thickness, wound in one layer only. To excite the power of electromagnets furnished with so few convolutions of wire, it was necessary to work with relatively large electric currents, and to this end Sturgeon devised special forms of voltaic cell. Such currents cannot be conveyed to great distances through thin wires, hence the distance from which such primitive instruments can be operated is very limited. This objection was removed in 1828 by Prof. Henry, who discovered the great advantage to be gained in distant working by increasing the number of convolutions of wire. He employed copper wire from 25 to 40 mils in diameter, covered with silk, and coiled on in many successive layers. Shortly after Henry's modification of the apparatus to the purpose of efficient working at a distance through long lines of wire, Joule made further modifications for the purpose of obtaining the greatest adhesive or tractive power, the special forms of electromagnet which he devised being distinguished by the compactness of their magnetic circuit. Other workers, such as Roberts, Radford and Romershausen, followed in the track. In the United States Page applied the coil-and-plunger form to the construction of electromagnetic engines. Telegraphic needs led to the production of forms of electromagnet adapted to rapid working. Other forms specially intended to secure a greater range of action or greater uniformity of pull within the range were developed under the necessities arising from the application of the electromagnet in the mechanism of electric arc lamps. Of all these various matters I have lately treated at some length in my Cantor Lectures before the Society of arts.

ANALOGIES BETWEEN THE ELECTROMAGNET AND THE STEAM CYLINDER.

In moving under the stress of the magnetic field the armature of an electromagnet may do mechanical work. The work done will, of course, be the product of the displacement into the average force. One is naturally led to institute a comparison between the work done in the stroke of an ordinary steam engine piston and the work done in the stroke of the armature of an ordinary electromagnet. In neither case is the force uniform from end to end of the stroke. In the case of the engine piston the pressure rises very suddenly at the beginning of the stroke remains at its maximum for but a very short period, then falls continuously to the end of the stroke, the precise manner of diminution being dependent upon the mode in which the valve is constructed and adjusted and upon the conditions of supply generally. In like manner the magnetic stress which urges the armature varies from end to end of the stroke, but in a wholly different manner. At the beginning of the stroke, when the armature is at some distance away from the fixed core, the stress is small. As it approaches, the magnetic field between them becomes more intense, and the stress, which is proportional to the square of that intensity, grows greater, becoming a maximum at the point of nearest approach at the end of the stroke. The range of motion in the case of the ordinary electromagnet is extremely limited, measurable in tenths, or more ordinarily in hundredths only, of an inch. This is due simply to the smallness of the stress when any considerable thickness of air is interposed. Herein arises so serious a disadvantage in the mechanical problem of utilizing electromagnets for motive power that the late Robert Stephenson

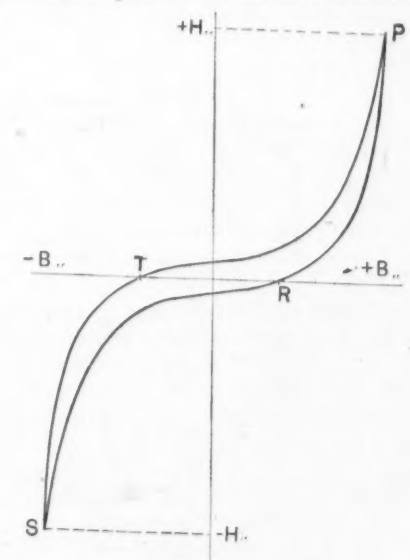


FIG. 3.

once gave this as an emphatic reason why electricity could never compete with steam power. Many devices have been suggested for increasing the range of action of electromagnets, of which more must be said presently. The coil-and-plunger form of electromagnet, which has a much greater range of motion though with feebler average force, presents a still greater similarity to the cylinder-and-piston mechanism of the steam engine. In this case the length of stroke and the distribution of the force between the beginning and end of the stroke depend not only on the length of the tubular coil but on the length and shape of the plunger. With a cylindrical plunger of soft iron of a length greatly exceeding that of the tubular coil, the pull increases gradually as the end of the plunger enters the mouth of the coil, becoming a maximum just as it emerges at the further end, and thence falls off again rapidly. If plungers are used not greater than the length of the coil, they reach the position of maximum pull when they are immersed to about half their own length into the mouth of the coil. A simple way of testing the fact is afforded by hanging the plunger to an ordinary spring balance and noting the pull exerted by the coil as the plunger is immersed to various depths, as

* Presidential address to the Junior Engineering Society, London.

in Fig. 1. A very short cylinder or a sphere of iron is only pulled just as it enters the mouth of the coil. With coned plungers the range is extended, long coned plungers being pulled with a force that increases even after their tip has begun to protrude through the end of the tubular coil.

It is extremely important to note that whereas the steam cylinder is, in almost all modern engines, the electromagnet is, in all ordinary cases, a single-acting mechanism. The armature is drawn magnetically up but not driven magnetically back. It is simply allowed to return, the electric current being cut off to enable it to move away. The only exceptions to this rule are to be found in the few cases where so called *polarized* armatures are used; that is to say, armatures previously magnetized in a particular direction. These can be alternately attracted and repelled by reversing the direction in which the current circulates around the electromagnet core.

This analogy between electromagnet and steam cylinder is no unimportant one. To the electric engineer the electromagnet with its armature constitutes the central organ of all electric machinery. Just as the mechanical engineer must acquaint himself to the last detail with all that goes on in the cylinder, must experiment and study, by the aid of indicator diagrams, the expansion of the working agent, the effect of the lap and lead of the valves, of fluid friction in the port-holes, of rapid condensation of the exhaust steam, and the like, so the electrical engineer must resort to experimental study, and use diagrams to enable him to follow the operations of the electromagnet, must watch the progress of magnetic saturation of the core, ascertain its retentiveness, observe the effect upon its performance of varying the configuration of the parts, of throttling the induction by insufficiency of section, and the like.

THE PRINCIPLE OF REVERSIBILITY.

Far as these analogies have been traced, they may be carried one stage further. The principle of reversibility which holds good of the steam cylinder holds good of the electromagnet also. In its usual function the cylinder and piston mechanism of the steam engine serves to convert the latent energy of the steam under pressure into mechanical work; but the very same mechanism is capable of serving the inverse function of employing mechanical power to compress steam, air, or any other gas. The pump is the inverse of the engine in its functions; its action is simply the action of the engine reversed. From the thermodynamic point of view the action is equally inverse. In the engine heat is converted into work, or in other words, entropy is let down from a high temperature to a low one, thereby furnishing energy to a mechanical system. Reversing the action, energy furnished by a mechanical system is employed to transfer entropy from a low temperature to a high one, and the apparatus becomes a machine for artificial refrigeration.

Turning to the electromagnet, energy furnished by letting electricity pass from a high potential to a low one is employed, magnetically, to produce a mechanical motion, and so to perform work. Reversing the action, energy furnished by a mechanical system is applied to an apparatus consisting of magnetic circuits and copper wire coils, which thereby becomes a machine for pumping up electricity from a low potential to a high one; in other words, it becomes a source of electric currents. The modern dynamo machine is simply an electric engine—a combination of iron cores and copper coils—capable of serving in either of two functions, as generator or as motor, each the inverse of the other.

RELATION BETWEEN MAGNETIZING FORCE AND MAGNETISM.

It is time to return to the principle of the magnetic circuit, briefly enunciated above, and to re-state it in more precise terms. The number of magnetic lines that will be evoked in any given magnetic circuit is directly proportional to the circulation of the surrounding electric current, and inversely proportional to the magnetic reluctance of the iron and air-gaps of the magnetic circuit. It is usual to specify the circulation of current in *ampère turns*, meaning thereby the product of the ampères into the number of turns of wire in the coil. The reluctance of the magnetic circuit must usually be calculated in parts, to be added subsequently together, allowance being made for leakage of magnetic lines. The reluctance of each part is proportional directly to its length, inversely to its cross-section, and inversely also to its permeability.

All known substances possess permeability, none having yet been discovered that is impermeable to the flux of magnetic lines. The vast majority of media—including air, all gases, all liquids, all organic solids, all compound bodies save three, all metals save three—have a small and constant permeability, not differing sensibly from that of vacuum. The exceptions that have a relatively large and variable permeability are the three metals—iron (including steel), cobalt and nickel (possibly also chromium and cerium), together with some of their alloys, and the compounds, loadstone (triferric tetroxide), pyrrhotine magnetic pyrites, and ferroso-cobaltic oxide. Of these only iron need be here considered.

MAGNETIC QUALITIES OF IRON.

Different specimens of iron differ widely in their permeability. Moreover, the permeability in any given specimen of iron varies with its degree of magnetic saturation; a sample that is already well magnetized being much less permeable than one that is less highly magnetized. Approximately the permeability of a specimen is proportional to the difference between the actual magnetic flux through it and the maximum flux that can be forced through it. A certain specimen of annealed wrought-iron for example, which became saturated to a practical maximum when permeated with 18,000 lines per square centimetre, had at 17,000 lines per square centimetre a permeability of 161, and when only pushed to 16,000 lines per square centimetre had a permeability of 320. The intensity of the magnetizing force at any point, usually denoted by the letter **H**, is often expressed by saying that it would produce **H** magnetic lines per square centimetre if acting on an air core. Now, if the space were occupied by a core of iron instead of air, there would be produced by the same magnetic force a larger flux of magnetic lines per square centimetre. This larger number expresses the degree of magnetization of the iron (also called the magnetic induction in the iron); it is denoted by the letter **B**. The ratio of **B** to **H** expresses the permeability of the material at that particular stage of magnetization. To ascertain the magnetic properties of any specimen, a series of observations must be made with various intensities of magnetic force. In any complete research a number of such series have to be made at different temperatures; as certain materials, notably the alloys of iron and nickel lately investigated by Dr. J. Hopkinson, change their magnetic properties much when heated. A series of such observations made by Dr. Hopkinson on a specimen of wrought-iron are represented by the curves in Fig. 2. Two liberties have been taken with this figure. In the first place, the numbers plotted out are the numbers of magnetic lines per square inch, instead of the usual numbers per square centimetre. In the second place, the magnetic forces are plotted vertically, and the resulting induced magnetization horizontally, the converse to the usual mode of plotting. The curve that starts from O represents the set of observations magnetic forces gradually increasing to about $\mathbf{H}_{\prime\prime} = 170$, when the resulting number of magnetic lines per square inch in the iron is about 100,000. It will be noticed that when the magnetizing force $\mathbf{H}_{\prime\prime}$ approaches the value of 100, the curve becomes very steep, any further increase producing relatively little increase in the magnetization. The second curve represents the result of then decreasing the magnetizing forces back to zero, when there remain behind a residual magnetization of no fewer than 47,000 lines per square inch. To remove these would require the application of a reversed (or negative) magnetic force of about $\mathbf{H}_{\prime\prime} = -13$.

Applying the principle of the indicator diagram to these curves, it will be seen that the area below the first of these curves, down to the zero line, and bounded on the right by the ordinate of the point P, represents the integral product of magnetic force into magnetization, and is consequently proportional to the work done (per cubic inch of the iron) in bringing about the magnetic state of things implied by the position on the diagram of point P. Similarly, the area under the descending curve represents the work restored in the demagnetizing of the specimen down to the state of things represented by the point R, when the magnetizing force has been removed. The narrow area enclosed between the curves represents the work not so restored, and for the expenditure of which the residual magnetism is all that there is to show. If the magnetizing forces are carried through a complete cycle of alternations from $+\mathbf{H}_{\prime\prime}$ to $-\mathbf{H}_{\prime\prime}$ and back, the resulting magnetization goes through a corresponding cycle, with the result that a definite closed area is completed between the curves in the diagram (Fig. 3). Were there no lagging in phase of the magnetization behind that of the magnetizing force, the ascending curves would coincide instead of enclosing an area. Some specimens of magnetic material—particularly pure octahedral crystals of magnetic iron ore—show no such lag. They exhibit practically no residual magnetization. The phenomena of lag have been studied particularly by Prof. Ewing and by Dr. John Hopkinson, to the former of whom we owe the term *hysteresis* to denote this lagging of effects behind the phase of their causes. When a specimen of iron is carried through such a complete cycle of magnetization, and brought back to the same magnetic condition as that from which it started, there is nothing to show in the way of residual magnetization; for in half the cycle work is spent in producing such a residuum, and in the other half work is spent also in destroying the residuum. In fact, the enclosed area represents the work lost by hysteresis. Its only effect is to heat the material; hysteresis being in magnetic problems as molecular friction in the problems of elasticity, always the cause of work being wasted.

(*To be continued.*)

The Telegraph in Budapest.

According to a correspondent of the *London Electrical Review*, there did not exist in Budapest a single telegraphic station prior to the year 1850. The earliest telegraphic station in the whole of Hungary was installed at Pressburg toward the end of 1847, exclusively for intercourse between Pressburg and Vienna. In the beginning of 1850 the telegraph station at Agram was opened, and not until Oct. 1, 1850, was a station installed at Budapest, in a side street, near the Carl barracks. The entire business done at this station in the first month amounted only to 72 telegrams, with total receipts of 381 florins.

In 1853 a second station was opened at Budapest in the Ofen Fort; in 1865 there were five, and in 1875 altogether seven telegraph stations in Budapest. After that time telegraphy was rapidly developed, so that there are now in the Hungarian capital 38 stations. In January, 1866, the intercourse in the city amounted to 1,284 telegrams, and in 1870 it reached the respectable figure of 778,717, with gross receipts of 107,838 florins.

In 1873 the present post and telegraph office was erected. In 1870 the entire duty was conducted by 94 officials, while at present 234 are employed at the central station, and 56 in the branch offices. Last year's business amounted to 2,955,648 telegrams, and required 2 8 officials.

The telegraph lines in Budapest extend, at present, to 91,412 kilometres; the telephone lines extend to 2,643 kilometers, with 1,245 stations for subscribers, and a traffic, last year, of 5,160,296 conversations.

Financial Intelligence.

THE ELECTRICAL STOCK MARKET.

The Prospect of Unlimited Coinage of Silver.—This subject is of great importance at the present time, and is shortly to be acted upon, and possibly to be made a law by our National Congress Some people are of the opinion that the unlimited coinage of silver furnishes the solution for all perplexing problems in finance. If a man goes to the United States Treasury to-day and presents paper money or silver and demands gold he can obtain it. Silver and paper money issued by the United States Government are therefore at this time on the same basis with gold. The amount of silver that can be mined is almost unlimited. The amount of gold, however, is limited. Supposing the bill for the unlimited coinage of silver passes, and, unfortunately, there is a prospect of it, the first result will be the hoarding of gold. Why? Because the law will be in the nature of an experiment and people that have gold will be inclined to keep it in preference to silver, because no matter what comes gold represents the standard of value, while silver may not retain its present position. The government of the United States will be called upon on the passage of this bill to exchange a large amount of its paper currency and silver into gold. A large amount of gold is needed in business, especially with foreign countries and for principal and interest payment on bonds, etc. This condition of affairs together with the hoarding which is bound to take place will make gold in greater demand than ever. We are forced then to face this condition with a standard of which there is a limited amount. The result will be that gold being in greater demand than silver, it will be at a premium. The estimated amount of gold in this country is $695,000,000, and is abundant for ordinary uses under our present financial system, but there is over a billion of currency of all kinds afloat now and is the prospect good for that immense amount of money, together with the vast addition produced by an unlimited coinage of silver, being as good as gold? The writer thinks not, because the Government can hardly redeem in gold this enormous amount of money. In order to demonstrate that gold is already commencing to find an increased demand look at the bond market. Bonds that have been drawn with principal and interest payable in gold find a good market. Those bonds that are not drawn with the stipulation of gold payments are a drug on the market, and it is doubtful now with the prospect before us of increased currency if a bond could be marketed at all unless a stipulation for payments in gold were contained. Another inference to be drawn from this statement is that people don't feel absolutely sure of any other standard of value than gold, and because the prospects of upsetting our financial system by free coinage legislation are greater than ever. The past financial crisis was not brought about by a scarcity of silver, but by speculation and an overissue of commercial paper. In demonstration of this the following table has been prepared, which shows that more money was in actual circulation in 1890 than in 1889. These balances were struck on July 1 of the years mentioned.

	1889.	1890.
Legal tender notes	$346,681,016	$346,681,016
Old demand notes	56,442	56,032
Certificates of deposit	17,195,000	12,390,000
Gold certificates	154,018,552	157,562,979
Silver certificates	262,629,746	301,539,751
National bank notes	211,378,963	185,970,755
Total	$991,989,719	$1,004,200,533

Money can be obtained on good security now just as readily as if the Treasury were loaded with silver to the roof.

The Unlimited Coinage Act makes a favored class in the producers of silver. The bill has been fathered by representatives from silver producing States. Most decidedly is it to the interest of these men, politically and financially, to pass this free coinage bill. The possessions of Nevada, for instance, outside of its silver mines, amount to very little, and the State for the most part is a dreary waste of land. It is very natural, therefore, that the representatives of that State and of States whose wealth is in part in silver mines, should fight for free coinage; but their efforts, nevertheless, represent superlative selfishness, and their success bids fair to bring disaster to our financial system.

The General Market.—Stocks in the general market this week have been very satisfactory in their course and closed higher than for some time past. Whether this advance in prices is likely to continue or not it is difficult to determine. The favorable signs are that money continues easy, that the bank statement for the week is better than has been shown for some time past, there having been an increase of $2,469,800 in specie, and $3,260,800 in legal tenders, making a total of $5,730,600; and that the prospect of a satisfactory understanding between the managers of Western railroads is good, and in fact almost accomplished. The dark side of the situation is the prospect of silver legislation. People, so far, seem to be of the opinion that, somehow, everything will turn out all right, and the market presents great strength.

Electrical stocks still continue on an upward course and show in many cases a splendid gain for the week. In the early part of December the rise of stocks with the first of the year was predicted in this column.

Edison stock has had a good market during the week and closed at 88, which is one point ahead of last week.

Thomson-Houston has been active and closed at 44¼, a gain of 1¼ points for the week. Ft. Wayne stock rose ⅝.

Western Union has reached 79⅝, which is 2⅛ points above last week's closing figure. This stock is likely to continue on its upward course.

Westinghouse has fallen from last report, and closed on Friday at 8¾. This is very low for this stock. It has an active market, however. A circular has been issued by Mr. Geo. Westinghouse, Jr., to the stockholders of the Westinghouse Electric Company, containing the following paragraph: "The arrangements to advance money to meet the requirements of your company for a reasonable time must be largely contingent upon the action of the stockholders themselves. If they make their subscriptions for the preferred stock in the proposed proportion to their present holdings of the common stock, in accordance with the terms authorized by the directors of the company, I have no doubt but what the affairs of your company will at once assume a satisfactory condition." There is little doubt that the stockholders will respond quickly to this notice, and the stock will find much better prices immediately.

Phonograph stocks of late have been rapidly dropping and now, so far as can be ascertained, are without a market. Litigation still continues and no one knows how long it will last, and the prospects for the stock are not very brilliant. The last price asked for North American Phonograph stock was about 15. F. Z. M.

The Closing Quotations of electric stocks, from F. Z. Maguire & Co., Electrical Securities, etc., 18 Wall street, New York, on Saturday, Jan. 10, 1891, in New York, Boston and Washington, and in Pittsburgh, Jan. 9, were:

Name of Stock.	Par.	Capitalization.	Bid.	Ask'd.
NEW YORK.				
Western Union Telegraph Co	100	86,200,000	79⅜	79¾
American Telegraph & Cable	100	14,000,000	83	85
Central and South American	100	5,600,000	145	160
Mexican	100	2,000,000	210	....
Commercial Cable Co	100	7,716,000	104	108
Postal Telegraph Cable	100	5,000,000	39	41
Edison General Electric Co	100	9,503,500	88	89
" " Deferred	100	2,496,500	....	....
Consolidated Electric Light	100	1,922 400	....	....
Edison Electric Illuminating Co	100	2,567,800	70	....
United States Electric Light	100	1,500,000	30	....
North American Phonograph	100	6,200,000	..	....
BOSTON.				
Thomson-Houston Electric Co	25	6,000,000	44¼	44⅛
" " preferred	25	4,000,000	....	26
" " Series C	10	400,000	....	....
" " Series D	10	120,000	5¾	6
" International Co	100	1,000,000	....	....
Thomson Welding Co	100	1 000,000	....	200
" European Welding Co	100	1,000,000	....	72½
Ft. Wayne Electric Co	25	4,000 000	10⅞	11½
Telephone:				
American Bell	100	12.500,000	213	214
Erie	100	4,800 000	49½	50
New England	100	10,504,600	51	52
Mexican	10	1,280,000	75c.	85c.
Tropical American	10	400,000	1	1½
MISCELLANEOUS.				
Edison Phonograph Doll	10	1,000,000	..	2
WASHINGTON.				
Pennsylvania Telephone	50	750,000	25	35
Chesapeake & Potomac	100	2,650,000	67	73
American Graphophone	10	600,000	*11¼	11½
United States Electric Light (Washington)	100	300,000	140	150
Eckington and Soldiers' Home Electric Ry	50	352,000	56	60
Georgetown and Tennallytown	50	200,000	49½	55
PITTSBURGH.				
Westinghouse Electric Mfg. Co	50	5,000,000	8¾	9

Telephone Quotations.—Col. S. G. Lynch, broker, 153 Monroe street, Chicago, furnishes quotations on Telephone stocks as follows:

Chicago	$290@$295	Cumberland	$60@ $62
Central Union	58@ 59	Wisconsin	118@ 120
Michigan	90@ 92	Bell of Missouri	160@ 165
Great Southern	30@ 32	Iowa Union	20@ 22
Colorado	34@ 36	Missouri and Kansas	54@ 56
Rocky Mountain Bell.	40@ 43		
ELECTRIC LIGHT STOCKS.			
Chicago Arc Light and Power	85@ 90	Chicago Edison	128@ 130

NEW INCORPORATIONS.

Delta, Pa.—A charter has been granted the Delta Electric Light Company, of Delta, York County. Capital, $5,000.

Glen Dale, W. Va.—The Glen Dale Company has been incorporated by George Adams, Wm. Erskine, D. L. Haskell and others, to establish a number of enterprises, one of which will be an electric light plant.

Waynesborough, Pa.—An electric signal clock company was organized at the Bolton House, last week. The factory will make a specialty of turning out first-class electric, signal and synchronizing clocks, the invention of John L. McCaskey, formerly of Perry County.

The Hunt Engineering Company, of Brooklyn, was incorporated last week with the Secretary of State, to manufacture electrical appliances. Its capital stock is fixed at $30,000, divided into 300 shares of $100 each, and the trustees are George W. Hunt, Albert E. Rich, T. Leeds Waters, Hiram W. Hunt and DeWitt N. Cole.

The Monon Electric Light and Power Company, of Homestead, Pa., has been granted a charter with a capital of $10,000. The directors are John Hollingshead, John S. Shaffer, Peter Fry, John Goeffner, John F. Cox, Joseph Lert, John Osbourne, M. D., J. H. Williams, Lawrence Offler, Frank E. Baldwin and D. R. McClure, of Homestead.

Danville, Ill.—The Citizens' Street Railway Company, the Danville Gas Company and the Danville Electric Light Company have effected a consolidation under the name of the Danville Gas, Electric Light and Street Railway Company; capital stock, $4,000,000. The incorporators are: F. W. Penwell, A. C. Daniel and W. P. Cannon. The new company will take charge of affairs on Jan. 1, and will soon consummate arrangements to operate the street cars by electricity.

Lockport, N. Y.—Articles of incorporation of a new electric railroad from Lockport to Olcott, a lake-side resort twelve miles distant, have been forwarded to Albany. The men at the head of the scheme are John Hodge, Willard T. Ransom, Eugene M. Ashley and others. The Lockport Street Railroad is operated by the same company and the trolley system will supersede horse power on this road, which will be run in conjunction with the other. It will also join the Rome, Watertown and Ogdensburg road near Olcott.

AFFAIRS OF THE COMPANIES.

The Annual Meeting of the Manchester (N. H.) Electric Light Company will be held Jan. 16.

The Narragansett Electric Light Company, of Providence, R. I., proposes to increase its capital stock $200,000 and with the proceeds retire its floating indebtedness.

The Clyde (N. Y.) Electric Light Company elected the following officers last week: President, E. Fred Stoetzel; vice president, Chas. H. Ford; secretary and treasurer, E. M. McIntyre.

The Southern Electric Company copartnership, at Baltimore, Md., has been dissolved, J. Frank Morrison retiring. D. Howard Tuxworth will conduct the business alone in future.

The annual meeting of stockholders of the Volta Graphophone Company, of Alexandria, Va., for the election of directors and for transaction of other business, was held on the 12th inst.

The Consolidated Gas and Electric Light Companies, of Annapolis, Md., held a meeting last week. The capital stock of the new company has been placed at $100,000, and all has been taken.

Babylon, N. Y.—The board of directors of the Babylon Electric Light Company has decided to increase the stock $10,000, adding a new dynamo for incandescent lighting, making a total of $20.000 capital.

Kingston, N. Y.—A meeting of the stockholders of the Kingston Electric Light, Heat and Power Company to consider negotiations of consolidation with the Rondout and Kingston Gas Light Company was held last week.

Pittsburgh, Pa.—At a recent meeting of the stockholders of the Pittsburgh, Allegheny & Manchester Traction Company, it was decided that the capital stock of that corporation should be increased from $1.000,000 to $1,300,000.

Louisville, Ky.—The officers of the new electric light company here are as follows: Marcus Ruthenburg, president and general manager; W. S. Love, St. Louis, vice-president; Herman Knirihm, secretary and treasurer; Paul Reising, John S. Briggs, W. V. Mallory, W. S. Loughmiller and Marcus Ruthenburg, directors.

Increased Earnings.—The Erie Telephone sub-companies show an increase of gross receipts for October and November over the same months of 1889 of $14,692.66; increase of expenses, $3 825.21, and increase of net earnings, $10,367.45. Net earnings are now at the rate of over $64,000 per annum more than they were in 1889, based on the two months mentioned.

The Rhodes Manufacturing Company, of Philadelphia, has made an assignment. It conveys no real estate. The company was incorporated on the 10th of March last for the manufacture of electric motors. It is stated that the authorized capital was $200,000, of which amount it was claimed $170,000 was paid in, made up of machinery, tools, stock, real estate and patents, the latter of which were valued at $50,000.

Norristown, Pa.—At the annual meeting of the Norristown Electric Light and Power Company last week the following were elected directors: Joseph Shaw, I. H. Brendlinger, George W. Smith, James McGinnis, Phillip Quillman, Isaac W. Smith, Samuel S. Kohn, J. Morton Brown, J. Evans Isett, Solomon Gilbert, John Slingluff. The board organized by electing Mr. Shaw president, Mr. Brendlinger vice-president, W. F. Solley treasurer and B. F. Kerper secretary.

Milwaukee, Wis.—A $10,000,000 mortgage, given by the Milwaukee Street Railway Company to the Central Trust Company, of New York, has been recorded here. The mortgage covers all the Villard interests in that city, represented by the property and various franchises of the recently consolidated Cream City and Milwaukee City Railway Company, and the two electric light companies. Under the terms of the mortgage the new company is permitted to issue $10,000,000 of bonds, to be disposed of by the trust company.

Brooklyn, N. Y.—The annual meeting of the Citizens Electric Illuminating Company was held last week at the office of the company, corner of DeKalb avenue and Rockwell place. The following board of directors was elected for the ensuing year: Thomas F. Nevins, James Shevlin, Anthony Barrett, Hugh McLaughlin, John Delmar. Messrs. E. F. Peck and P. Whitehead acted as inspectors of election. The new board have met and elected for the current year the following officers: John Delmar, president; Hugh McLaughlin, vice-president; Anthony Barrett, secretary; Thomas F. Nevins, treasurer.

A special meeting of the stockholders of the Allegheny County Light Company, of Pittsburgh, Pa., was held last week to consider the issuing of more stock. According to the statements of the condition of the various Westinghouse companies given out recently, the Allegheny County Light Company has an indebtedness of $400,000, besides a bonded debt of $250.000. Following are the figures presented at the meeting:

	1888.	1889.	1890.
Gross earnings	$153,405.25	$224,287.39	$305,763.20
Operating expenses	117,499.63	145,779 76	199,438.55
Earnings	$35,905 62	$78,507.63	$106.324.05
Interest, etc	20,602.33	31,184.67	39,724 50
Net earnings	$15,303.29	$47,322.96	$66,600.15

The comparative statement of lamps operated is as follows:

	Dec., 1888.	Dec., 1889.	Dec., 1890.
Incandescent 16 c. p. lamps	20,145	27,829	33,500
Arc lamps (2,000 c. p.)	240	767	857

Special Correspondence.

NEW YORK NOTES.

OFFICE OF THE ELECTRICAL WORLD,
167-177 TIMES BUILDING, NEW YORK, Jan. 12, 1891.

Mayor Grant has been in Boston to examine the trolley system of the electric cars.

Housetop Wires.—Dr. Wheeler, of the Board of Electrical Control, has been asked to make a report of the housetop wires in this city.

The Standard Electric Company, of Vermont, has installed a 500-light plant for the Washington Market Company, of Washington, D. C.

Mr. C. S. Van Nuis has made a large shipment of his "Ajax" switches and other specialties for use in the new plant of the Buffalo Street Railway Company.

Law Telephones.—The business of the Law Telephone Company has increased about 20,000 cells during the past year, and the outlook for this year is very encouraging.

Messrs. Stanley & Hall, of this city, have had a very prosperous year. Their business in house furnishings and supplies shows an increase of fifty per cent. over last year.

Mr. C. E. Newton and C. L. Tolles, of the Jewell Belting Company, were in town this week. Some large belting contracts were taken by these enterprising business men.

Mr. A. V. Garratt, of the National Construction Company of Boston, was in New York Thursday, having just returned from a successful business trip to California and the West.

The United States Electric Lighting Company is installing a plant in the new Holland Hotel on Fifth avenue, and is wiring it throughout with Grimshaw white core wire.

Electric Club.—The next regular meeting of the New York Electric Club will be held Jan. 22. Mr. Franklin L. Pope will deliver a lecture entitled "Notes on the Electric Railway, Historical, Statistical and Technical."

Mr. Eugene F. Phillips, of the American Electrical Works, Providence, R. I., who was in the city the early part of last week, says the new wire being brought out by his company is made of excellent material, and will be fully appreciated by all users of wire.

Mr. A. H. Eddy, president, and Mr. A. D. Newton, general manager of the Eddy Electric Company, were in town this week, and report business as booming. This company has a very large number of motors in use, for factory purposes, in the United States and Canada.

The National Electric Manufacturing Company has just installed 330 52 c. p. lamps in Jamaica, L. I., using the alternating current with its transformer system. The lights are burning brightly and giving satisfaction. This company has also installed a 1,000 light National alternator in Dover, N. J., and is having a large sale for its transformers in all parts of the East.

Protective Organization.—A call has been issued for a convention with the view of forming a national organization of electrical wage workers. It states that the objects of the proposed new organization will be to protect its members against incompetent persons who work for a pittance, to secure a fair day's pay for a fair day's work, to maintain their rights as mechanics in the different branches and to co-operate with and receive the support of other trade organizations.

The Walker Electric Company, of this city, is doing a nice business with its ammeters and voltmeters. Its ammeter for arc light circuits is a very carefully adjusted instrument. The following sales are reported: Narragansett Electric Light Company, Providence; Indiana University, Bloomington, Ind.; Steuben Electric Company, Hornellsville, N. Y.; Lebanon Electric Light Company, Lebanon, N. Y.; Mt. Holly Electric Light and Power Company, Mt. Holly, N. J.; Holtzer-Cabot Company, Boston; Gould's Manufacturing Company, Seneca Falls, N. Y.; Electro-Dynamic Company, Philadelphia; Pacific Electrical Storage Company, San Francisco. Mr. Wm. Hood, of Chicago, has taken the general agency for the State of Illinois.

The Magnetic Club.—Mr. Edward C. Cockey, president of the club, is endeavoring to advance its interests in every way possible, as is shown by the following letter, which he is sending to the members. He says: "As your president for the present year, I beg to greet you and to say to you that it will be my effort to please you, and to do all within my power to advance the interests of the club and to make this a year of unprecedented success. This success will not come from my efforts alone. I therefore appeal to you personally to co-operate with me, and make my burden as light as possible. Kindly give your material aid to the advancement of the interests of the club. Improve the attendance at its social meetings by your presence, and do all that you can by your individual effort to aid me to bring the club to a high standard of social excellence. If you can give me a written assurance to the above effect, it will have a wonderful influence in inspiring me."

American Institute of Electrical Engineers, New York.—The 53d meeting will be held at 8 o'clock, on Tuesday evening, Jan. 20, at the Rooms of the Institute, No. 12 West Thirty-first street, near Fifth avenue. The session will be devoted to the discussion of the following subjects: Inductance and its proposed unit the "Henry." This discussion of Mr. Kennelly's paper, postponed from the last meeting, will be opened by Dr. Cary T. Hutchinson. The paper will be found printed in full and revised by the author in THE ELECTRICAL WORLD of Dec. 27, 1890. Reports of the following committees will also come up for action: The standard wiring table committee, committee on the value of the "Henry," committee on amendment of the patent law. Copies of the report of the first two committees will be furnished upon application to the secretary. Non-resident members who are interested in the above subjects are invited to contribute their views in writing. The 54th meeting will be held at the same hour and place, Feb. 17, and the 55th meeting, March 17. L. H. H.

NEW ENGLAND NOTES.

BOSTON, Jan. 10, 1891.

Pierce Bros., of Leominster, Mass., have just completed equipping the Essex Road at Salem with their appliances.

The Electric Club, of the Massachusetts Institute of Technology, held a banquet at Young's Hotel Friday evening, Jan. 2, at which were present Professor Cross, H. E. Clifford and W. D. Puffer as invited guests. Professor Cross gave a résumé of the work of the institute, and Mr. Clifford compared the institute's technical laboratory with those of foreign countries. Other speakers made remarks on electrical progress.

Boston, Mass.—The drivers and conductors of all electric cars of the West End street railway were notified Monday that, beginning yesterday, their wages will be increased from $2 to $2.25 per day. Drivers are instructed to keep a sharp lookout for cars ahead, and never approach another car on the same track nearer than 100 feet, except in the down-town section, or when it is absolutely necessary elsewhere for proper operation; to run the cars strictly in accordance with printed time schedules, and if delayed from any cause never to seek to make up for lost time by fast running. Conductors are instructed never to ring to start until they are absolutely sure that passengers are fairly on or off the car.

Lawrence, Mass.—In 1889 the city was paying at the rate of about $12,000 for lighting, of which $2,640 was paid to the Lawrence Gas Company for 22 arc lights. The remainder was paid to the Edison Electric Illuminating Company for about 540 incandescent lights of 10 and 16 c. p. In the fall of 1889 the contract with the Edison Company was amended so that all lights were 20 c. p., the increase in cost being about $3,000 or the total cost about $15,000. As both the contracts with the gas company and the Edison Company expired in October, 1890, the Committee on Streets was given full power to make new contracts for street lighting. The appropriation for 1890 was $20,000. The committee expected to be able to light the city fairly well for that sum for the coming year, but after careful consideration found it necessary to exceed that amount about $2,000, and at present the total number of lights is 80 arcs and about 640 incandescents, or an increase above the number in 1888 of 58 arcs and about 100 incandescents. The city is now very well lighted, although there are probably some places which require more or different lights. C. A. B.

PHILADELPHIA NOTES.

PHILADELPHIA, Pa., Jan. 10, 1891.

Wilmington, Del.—A severe storm caused great damage to the electrical circuits here last week.

The Moorestown (Pa.) Electric Light Company has decided to supply all commercial consumers through meters, at a rate of three-fourths of a cent per ampère. Domestic consumers are given the same privilege, and many of the consumers have decided to take their light by meter, at the same rates, claiming a saving over the contract rates.

Uniontown, Pa.—The gas and electric light companies have made up their minds that competition is not a profitable thing, and have accordingly joined forces under the title of the United Light Company. The old gas company was known as the Heat and Light Company, of Uniontown; the electric company as the Electric Light and Power Company, of Uniontown. As a result of the combination prices have been put up to a paying basis.

Messrs. Jos. C. Paulus & Co., agents for the well known Chas. Munson Belting Company, have opened a store at 3-7 North Fifth street, Philadelphia, where they have a complete line of belting, lace leather, scrap leather, etc., as well as a repair shop, fitted up with the most approved machinery. Mr. Paulus has had a wide experience in the belting business, and was manager of Chas. A. Schieren & Co.'s Philadelphia house for over twelve years.

Removal.—The firm formerly known as Partrick & Carter, manufacturers of electrical supplies and located at 114 South Second street, will be known hereafter as Partrick & Carter Company, and will be found at 125 South Second street, where the company has recently moved and occupies five floors of a building 120 × 50 feet. With the greatly increased space, machinery and force, this company will be better prepared to meet the increasing demand for its goods.

The Thomson-Houston Electric Light Company, of this city, has just completed a very successful year. The sales of the last week comprise the following: Monterey, Mexico, 35 arc and 1,300 alternating incandescent; Lock Haven Electric Light Company, 50 arc and 650 incandescent; Germantown Electric Light Company, 400 incandescent; Hudson Electric Light Company, Hoboken, N. J., 650 incandescent; McKeesport Light Company, Mc Keesport, Pa., 50 arc; Eastern Penitentiary, Philadelphia, 450 incandescent; Monmouth Park Hotel, Monmouth Park, N, J., 800 incandescent.

The Philadelphia Branch of the Westinghouse Electric and Mfg. Company., C. A. Bragg, agent, has just made the following installations: S. A. Rudolph, Manayunk, United States system, 150 lights; Selser, Meuer & Co., Philadelphia, United States system, 150 lights; Wm. Simpson & Sons, Norristown, United States system, 300 lights; Eddystone Manufacturing Company, Eddystone system, 1,200 lights; Erie ferryboat Jno. McCullough, United States system, 135 lights; Bryn Mawr Hotel, Bryn Mawr, Pa., two Westinghouse compound engines, two 600-light United States dynamos, one 25-light United States dynamo, building to be wired for 1,500 lights, and the entire installation to be of white core Grimshaw wire and finished in the most modern manner. W. F. H.

WESTERN NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
465 The Rookery, Chicago, Jan. 10, 1891.

Mr. W. A. Jackson, vice-president of the Detroit Electrical Works, has been a welcome visitor to Chicago this past week.

Prof. John P. Barrett, city electrician of Chicago, will receive the heartfelt sympathy of his many friends in the recent loss of his aged mother.

A new shop for the manufacture of electric specialties is now being fitted up at Chicago by Mr. George Cutter. This will enable him to meet the demand for the patented specialties which he controls.

Mr. J. B. Crouse, vice president of the Standard Carbon Company, spent a few days in Chicago this week in the interest of his company. Mr. Crouse speaks very encouragingly of the prospects for business in his particular line.

Excellent Work.—Since Aug. 1, 1890, Mr. C. A. Ross, manager of the Kansas City office of the Thomson-Houston Electric Company, has sold complete apparatus aggregating 225 arc lights, 5,850 incandescent lights and 13 h. p. in motors.

Chauncey M. Spaulding will shortly leave Chicago for the Pacific Coast, where he will remain for some time in the interest of the Electrical Supply Company, of 175 Randolph street. Mr. Spaulding has the reputation of being an excellent salesman, and will no doubt make many warm business friends in his new position.

The Chicago Electric Club held its first regular meeting of the new year Monday evening, Jan. 5. The treasurer, in his regular report, urgently requested every member to pay in full the amount of the recent assessment. The paper of the evening was upon the subject of "Practical Electricity," by Mr. N. H. Hodson, and dealt with the statistical and financial side of the subject.

The Composite Photograph of the Electrical Supply Company, of Chicago, is the central feature of their New Year's announcement. The likenesses of those in charge of the various departments—ten in number—combined in this way, produce an effect that is striking to say the least. Composite photography, while not exactly a new art, has not, we think, been used in this way before. The faces resulting from this process, though impossible, are of interest as typifying the combined characteristics of those represented.

Mr. C. B. Holmes has severed his connection with the Chicago City Railway Company. Mr. Holmes has been at the head of a syndicate of capitalists who have conducted extensive operations in the street railway field. He has been actively interested in electric railway matters, and several large roads which have passed into the hands of the syndicate have been equipped electrically. Among the more notable of these may be mentioned the Indianapolis (Ind.) Street Railway, the Lindell Street Railway, of St. Louis, and the Moline, Rock Island and Davenport railways.

Denver, Colo.—The Denver Consolidated Electric Company employs 110 hands, and pays yearly in wages $100,000. It has 300,000 alternating current lamps, 1,500 street lights, and 1,100 arc lights. The product for 1890 amounted to $300,000. The Western Electrical Construction Company was organized Aug. 7, 1889, with a capital stock of $500,000. In August, 1890, it purchased the plant located at Sixth and Lawrence streets, then belonging to the Denver Electric Illuminating Company. Since then the Western Company has been engaged in erecting an additional plant of twice the capacity of the plant purchased from the Denver Electric Illuminating Company. The present capacity is 90 2,000 c. p. arc lamps, and 8,000 16 c. p. incandescents. When the new plant is completed the company will have a capacity of 1,600 arc lamps and 20,000 incandescents. It employs 60 men, and the salary roll amounts to $80,000 per annum. The officers of the company are: H. A. W. Tabor, president; Peter McCourt, treasurer; and M. C. Stern, secretary and general manager. H. C. E.

SOUTHERN NOTES.

NORFOLK, Va., Jan. 10, 1891.

Jasper, Tenn.—Efforts are being made looking to the establishment of an electric light plant.

Athens, Ga.—The work of constructing the electric road was begun on the 5th inst., and is being pushed forward rapidly.

Galveston, Tex.—The Galveston City Railroad Company is building a power house, and will equip its lines with electricity at a cost of $200,000.

Columbus, Ga.—The State Legislature has granted a charter to the North Highland Electric Railway Company, which intends building an electric line.

Comanche, Tex.—It is stated that the Fort Worth Construction Company, of Fort Worth, Tex., will probably erect an electric light plant and ice factory.

Savannah, Ga.—The new electric street railway company, of which J. T. Collins is president, is completing its survey and will soon advertise for construction bids.

Wilson, N. C.—A town election has been held and authority voted for the issuing of $15,000 of bonds for the erection of an electric light plant, and the City Council is now negotiating for the necessary equipments.

Atlanta, Ga.—At a recent meeting of the city council the office of superintendent of electric light was abolished. This position has been held for some time by Mr. W. J. Bagby, who, it is said, has made an efficient officer. During the same meeting an ordinance was presented on underground wires, authorizing the Southern Bell Telephone and Telegraph Company, of the city of New York, to construct and operate an underground system in the city of Atlanta, Ga. This ordinance was opposed by Mr. Woodward, who presented an amendment to the fourth section, which provided that nothing contained in the ordinance should be so construed as to prevent any future council from exercising its right to repeal or amend the ordinance in the interest of competition and to grant any other telephone company the right to occupy the streets and alleys of the city of Atlanta. The ordinance as amended was adopted. V. N. B.

WASHINGTON, D. C., Jan. 10, 1891.

Superintendent Miles, of the police telegraph and telephone service, in a strong recommendation to the commissioners of the district, has called attention to the immediate need of new telegraph poles to replace the dangerous ones in this city. In response to a request of the commissioners for information as to the number of poles that should be immediately replaced, to insure the safety and efficiency in the telegraph and telephone services, Superintendent Miles says that after a careful count and inspection he finds that 238 new poles will be necessary to replace an equal number of unsafe ones, 173 of which ought to be 65 feet long, and the remaining ones reduced to 50 feet in length. The average cost of these poles with the necessary crossarms and insulators, all ready for the wires, will be $30 per pole, and will amount to $7,140. One hundred miles of copper wire will be necessary, he says, to take the place of the iron wire now in use since 1875 and which by reason of decay from rust is no longer reliable. This wire will cost $2,500, making a total cost with labor of $10,000.

An Electrical Commission.—Congress during the last session expressed the firm intention of allowing no more overhead electric wires to be erected within the District of Columbia. Attempts have been made to forbid the erection of such wires even in the adjacent county. The District Appropriation bill passed during the last year provided for an electrical commission to take into consideration and report to Congress such facts and recommendations in regard to the entire subject of electric wires in the district as could be gathered. In October last, the president appointed this commission. During the past week Mr. Andrew Rosewater, of Omaha, Neb., and Lieut. Francis R. Shenk, of the Army Engineer Corps, arrived in the city, and were met by Professor Rowland of Johns Hopkins University. These three constituted the commission. A meeting was held and an organization was effected. The ground to be covered in their investigations was looked over. Mr. Rosewater is an engineer and familiar with public works, being Omaha's city surveyor. The duties of the commission are largely of an advisory nature, as they have no executive powers. They are given until the first of next December to complete their work, and to send their report to the president for transmission to Congress. The commission is to consider the location, arrangement, and operation of the electric wires in the District of Columbia for all purposes, with a view to securing as soon as practicable the construction of a safe and convenient system of conduits or subways, the placing therein of all necessary electric wires along the streets and other public places, and the removal of all overhead wires and their support. E. A. O.

Answers to Correspondents.

Questions to be answered in this column must be of general electrical interest, and must be accompanied by real name and address as a guarantee of good faith. No notice will be taken of questions regarding apparatus unless enough details are given to permit a definite answer, and no dynamo or motor designing will be done.

Forming Secondary Battery Plates.—I wish to build up some secondary battery plates of the pasted type. Can you inform me through your columns where I can find practical information with regard to this work? T. L.

You can find a very good general account of pasted and other secondary cells in Reynier's "Voltaic Accumulators." The ELECTRICAL WORLD for Dec. 13 contains in Prof. Ayrton's paper some valuable practical points as to the method of construction of one type of pasted cell. The mixture of the oxides of lead with sulphuric acid should be very intimate and the oxides in very fine powder.

Earth Coil.—Please explain what Prof. S. P. Thompson means by "earth coil" and "earth reversing coil." He uses the terms in his article on electro-magnetism. C. P. L. N.

The earth coil, better known as earth inductor, is simply a coil of wire of accurately known dimensions arranged so that it can be revolved 180 degrees. It is used for the investigation of the magnetic field produced by the earth. By turning it 180 degrees about a horizontal axis parallel to the magnetic meridian, a current will be set up in it proportional to the vertical component of the earth's magnetism. On the other hand, by turning it 180 degrees around the vertical axis the induced current will be proportional to the horizontal component of the earth's magnetism. Knowing the exact dimensions of the coil, the intensity of the magnetic field produced by the earth may be obtained from the induction produced; or, knowing the former, the strength of the magnetic field can be readily obtained by comparing its effect on a similar bit of apparatus with the known effect produced by the earth's field.

A New Process of Producing Electricity.—In a recent number of the *Electrotechnishe Zeitschrift* from Berlin, I find the following note on "A New Process to Produce Electricity," given without any additional comment, and I should be pleased to learn if you think that producing electricity in the way mentioned would be possible: "Mr. Mandereft, a doctor at Geuf, publishes in the London periodical, *National Scientific*, a process to produce electricity in before 'ur supposed' quantities, and nearly for nothing. This gentleman makes with a half horse power so much electricity as to supply 500 incandescent lamps. His apparatus consists of one degree of a hollow ball of zinc of 50 centimetres diameter; two degrees of a hollow ball of copper of 40 centimetres diameter. The copper ball being placed within the zinc ball, both balls are turned with a speed of 500 revolutions in opposite directions; but in this case there will be no remarkable electrical events; but as soon as there is led in the space between copper and zinc ball steam of five atmospheric pressure, an enormous current is produced, the intensity of which is still increased by increasing the speed and the pressure of the steam, etc." (No. 46, page 613. Nov. 14, *Electrotechnishe Zeitschrift.*) F. B.

The note in question refers to what is undoubtedly an egregious humbug. We are surprised that so reliable a journal as the *Electrotechnishe Zeitschrift* should have taken any notice of it.

News of the Week.

THE TELEGRAPH.

Western Union Deal.—It is reported that the Philadelphia, Reading & Pottsville Telegraph Company is to pass into the hands of the Western Union.

Mackay-Bennett Cable Company.—The rumor of a difficulty between Messrs. Mackay and Bennett and of the intention of the New York *Herald* to abandon the use of the Mackay-Bennett cable was declared to be without foundation by Mr. Mackay a few days ago.

Ottawa, Ont.—Colonel Volney V. Ashford, of Honolulu, who has arrived at Ottawa to confer with Mr. Foster, Minister of Finance, alleges that the island's trade relations with the United States have become unsatisfactory. He had a talk with Sanford Fleming, and urged that the Pacific cable be laid by way of Honolulu.

Newark, N. J.—The Postal Telegraph Company has asked for the privilege of extending the lines of the company in that city. They said that the plant of the company in this city would cost about $1,000 to construct, and offered to pay 2½ per cent. franchise tax under the Connelly ordinance on that sum. The proposal was agreed to.

Ottawa, Ont.—The projectors of the Canada Atlantic cable, which it is proposed to lay between the Strait of Belle Isle and the west coast of Ireland, are endeavoring to secure a guarantee of £100,000 of their bonds by the Dominion Government. The estimated capital required is £500,000, of which £100,000 has been subscribed. The directors say that if the Dominion Government will guarantee the bonds as asked they will have no difficulty in disposing of the stock. An effort is again being made to induce the Dominion Government to ask Parliament to vote the amount required to lay a cable from Nova Scotia to Sable Island.

THE TELEPHONE.

Mt. Vernon, Ind., will soon have telephone connection with Evansville.

Bridgewater, Mass.—A new telephone wire is to be erected from Bridgewater through Whitman to Plymouth.

Adelaide, Australia.—The colony has amended its telephone regulations, the principal changes being in subscription prices.

Mt. Vernon, Ind.—The Cumberland Telephone Company has secured the right of way in Mt. Vernon, Ind., and will put in an exchange. Thirty instruments have been subscribed for.

Alpena, Mich.—The Presque Isle County Board of Supervisors have given a bonus of $1,000 for a telephone line from Alpena to Rogers City. They expect to have the line completed by April 1.

Wilmington, Del.—The first trial of the new telephone system, introduced in Wilmington last week by the Delaware and Atlantic Telephone Company, met with the approval of most of the subscribers.

Nashua, N. H.—Charles H. Nudd, of Manchester, agent for the new Shaver telephone corporation, recently gave an exhibition of the new telephone to a number of business men of Nashua, with a view to forming a stock company.

Telephones in Japan.—The Tokio and Yokohama telephone exchanges have very recently commenced operations and have a large number of subscribers. The instruments are made under the superintendence of the government.

Elkton, Md.—C. H. Smith and C. G. Wells, of Elkton, Md., have purchased the old telephone line in Cecil County, Md. The new company will be known as the Cecil Telephone Company. Elkton, Rising Sun, Port Deposit, Chesapeake City and the almshouse will be immediately connected and other points as application is made. The exchange will be located at Elkton.

Buffalo, N. Y.—Professor Root, accompanied by 25 pupils of the first grade of No. 19 school, of Buffalo, enjoyed a novel experience a few days ago through the kind courtesy of Mr. Vezey, the superintendent of the Bell Telephone Exchange. The pupils were highly delighted with the practical results gained, being treated to a cornet solo from Warsaw, N. Y., and a whistling solo from New York City.

Mr. Tomlinson, of Elmira, N. Y., electrician of the New York and Pennsylvania Telephone and Telegraph Company, is superintending the removal of the local exchange from its present quarters to the rooms now occupied by Superintendent Stearns. A force of men are at work stringing the wires, and the change will be made without any inconvenience to the patrons of the exchange. Mr. Stearns is undecided as to where he will move his office.

East Orange, N. J.—An interesting electrical experiment was made in Orange a few evenings ago. John B. Dill, a well-known lawyer of East Orange, connected the funnel of his phonograph with the telephone transmitter in his house, and, through the central office, was placed in connection with about 25 different houses in Orange, West Orange, Jersey City and Brooklyn. A number of cylinders were used and the reproduction was clear and distinct in all.

Syracuse, N. Y.—The Syracuse exchange of the Central New York Telephone and Telegraph Company was first put into operation in July, 1887, and since then the business has increased steadily. The capacity of the exchange has been increased several times, but it is not yet sufficient, and workmen are now tearing out one side of the operating room preparatory to building an additional section of the switchboard. During the last year the average business has been 10,000 calls daily.

Boston, Mass.—The next city government will inherit the report of the committee on bonds, on the petition of the New England

Telephone and Telegraph Company of Massachusetts, recommending, in consideration of an indemnity bond given by the company for $20,000, dated Sept. 6, 1890, that the obligation of the surety on previous bonds, dated May 9, 1889, and Nov. 26, 1889, be released—not, however, releasing, but reserving all obligations of the principal obligors in each of the latter bonds.

THE ELECTRIC LIGHT.

Avoca, Ill., is to have electric lights.

Madison, Ia., is to have electric lights.

Montpelier, Ind., wants electric lights.

Spencer, Ill.—The electric light plant is under way.

Corunna, Mich., expects to have electric lights shortly.

Union City, Ind., will have incandescent lights by Feb. 1.

Union City, Ind., will have an electric light plant by Feb. 2.

Antwerp, O., is thinking of having an electric light plant.

Iowa Falls, Ia., is considering a proposition to have an electric light plant.

Allegan, Mich., is considering the question of owning its own electric lighting plant.

New Albany, Ind.—An electric light company has been formed with $100,000 capital.

Cheney, Wash.—The contract has been let for the building of the Cheney electric light plant.

Haverstraw, N. Y., is agitated by the problem of investing $20,000 in an electric light plant.

Cape May, N. J., will have a municipal plant after May 1, when the contract with the local company will expire.

Crawfordsville, Ind.—The present electric light company at Crawfordsville will sell the plant to the city upon favorable terms.

Herkimer, N. Y.—The electric light poles are being placed in position and it is hoped the plant will be in operation in a few days.

Nashua, N. H.—Although the appropriation for street lights in Nashua, N. H., was raised this year from $10,000 to $13,000, it has been overrun.

Keokuk, Ia.—The Keokuk Electric Light and Power Company has advertised that for the next 60 days it will furnish private families six lights for $2 per month.

Nauvoo, Ill., is now talking of establishing an electric light plant. At a special meeting of the council, on Monday evening of last week, a committee was appointed to consider the question.

Rushville, Ill.—The authorities have closed a contract for the lighting of that town's streets by electricity. Twenty-two arc lights, each of 2,000 candle power, are to be furnished at $20 a lamp per annum.

Springfield, Vt.—Initial steps were taken Tuesday evening of last week toward the organization of the Springfield Electric Light Company. Enough stock was subscribed to make the enterprise a success.

Crawfordsville, Ind.—The city council of Crawfordsville passed a resolution to the effect that an electric light plant be established, not to cost over $25,000, exclusive of ground and building last week.

The Elmira (N. Y.) Gas and Illuminating Company has purchased, through S. N. Blake, general agent of the Easton Electric Company, another 50 light arc machine with complete equipment.

Doylestown, Pa.—L. E. Myer, of the Edison Electric Light Company, has closed a contract with James Kane, by which Mr. Kane will now build a plant of 40 arc light and 750 incandescent light capacity.

O'Neill, Neb.—The new electric light plant for O'Neill, put in by Donald McLean of the Short Line, was operated for the first time last week. There are five arc lights for the city and three for the Short Line.

THE ELECTRIC RAILWAY.

Bridgeton, Pa., is to have an electric railway.

Winthrop, Mass.—An electric road is contemplated.

New York, N. Y.—Park Commissioner Hutchins, in behalf of the Harlem Bridge, Morrisania & Fordham Railroad Company, has presented an application for permission to operate an electric railroad by the trolley system.

Thomaston, Me.—At the town meeting last week it was voted to permit the electric railroad to run through the town, coming from Rockland over the new county road to Fish street, through Thatcher street, and up Knox street to Main.

The United Electric Railway Company, of Nashville, Tenn., has filed in the Register's office an amendment to its charter, providing for the extension of all its lines over various streets, roads and avenues in and outside of the city limits.

Sidney, New South Wales.—The trial section between Waverly and Randwick (two miles in length), recently equipped by the Thomson-Houston Electric Company, has made a good impression on the public there, though they favor underground systems.

Troy, N. Y.—The Troy & Albia Horse Railroad Company has applied to the State Railroad Commission for permission to change its motive power from horses to electricity. Decision was reserved. The city of Troy has already granted the permission now asked of the Railroad Commission.

The East Middlesex (Mass.) Street Railway Company is considering the advisability of adopting the electric system on its line from Chelsea to Woburn, a distance of ten miles. The running time at present is two hours. By using electricity the trip could be made in 45 minutes.

Pittsburgh, Pa.—Controller Morrow, of Pittsburgh, Pa., who is ever alive to the interests of the municipality he serves, has arrived at the opinion that the cable and electric street railway companies of the city, being in possession of valuable rights which allow them to carry on their business, should be subject to taxation for the running of their cars, having heretofore been exempt from the usual vehicle tax.

Camden, Mass.—The selectmen of Camden have again refused the request of the Camden & Rockport Electric Railway Company to locate its track through the streets of Camden, giving as their reasons for so doing that the construction of the electric road at the present time is liable to interfere with the Penobscot Shore Line; that the sentiment of the people of the town is strongly adverse to the electric road, and that public convenience does not at present warrant the construction of such a road.

Newport, R. I.—Cornelius Vanderbilt, Fairman Rogers, H. A. C. Taylor, Julien T. Davies and Henry G. Marquand have asked the City Council to order the unconditional removal of the Electric Car Company's tracks on the beach route within ninety days, because the company "has repudiated its agreement" to remove them voluntarily providing the city would lay out a new route to the beach. The petitioners are a sub-committee of the Newport Improvement Association, which was organized to prevent the introduction of electric cars. The association is made up of the leading summer residents, who offered to give the railroad company $20,000 to compensate it for the removal of its tracks, and the sum of $13,000 additional was offered the city toward the expense of the new road.

Uniontown, Pa.—The track for the Electric Street Railway Company is completed, the poles are set and the trolley supports are being put on. The location of the power house has been changed from Grant avenue to Main street, which is about midway along the line of the road. It is still a secret from the public as to what system of dynamos and motors is to be used. This company has made application to the borough authorities at New Haven (13 miles north of Uniontown) for permission to put down an electric railway in that borough, which is connected with Connellsville by a suspension bridge. It is thought that it is the company's intention to connect the two previously mentioned boroughs with Uniontown the coming spring.

APPLICATIONS OF POWER.

Power Transmission in Japan.—The city of Kyoto is making arrangements for the supply of energy to be transmitted electrically to the various factories in the city and neighborhood as well as to work the machinery in the lock gates of the canal.

The Grindstone Coal Mine, located near Brownsville, Pa., and operated by Philadelphia capitalists, is to be fitted with both electric light and power. The motors will be applied to the mining machinery, pumps, etc. Estimates are out, but the contract has not yet been given.

Latrobe, Pa.—The Loyalhanna Coal & Coke Company have contracted with the Edison Company for an electric mine haulage in their Latrobe mines. It is said that it will be the largest electric mine haulage plant in the United States. It will consist of one locomotive, capable of delivering hourly 120 cars to the bottom of the shaft, each car containing 2½ tons of coal. This would make the output 300 tons of coal per hour. The gross weight of the trains to be hauled will be 120 tons. About 3,000 feet of gangway will be equipped with conductors at the start, but as the lengths of the gangways increase this will have to be increased to 10,000 feet, and the company is then expected to put in a second locomotive of equal capacity to the one mentioned above.

LEGAL NOTES.

American Bell Telephone Company.—In the United States Circuit Court Judge Colt has granted a further extension for three months from Jan. 1, 1891, for taking testimony in the suit of the United States against the American Bell Telephone Company.

Injunction Against the City of Philadelphia.—Judge Gordon, on motion of Lawyers Alexander and Magill, has continued the preliminary injunction which was granted on the 26th ult., restraining the City of Philadelphia and its officers and agents from cutting or in any way interfering with the wires or other property of the Electric Power Company. The injunction is continued until the further order of the court.

Tampa, Fla.—Judge Hanson has decided the case of the Florida Electric Company, of Tampa, against R. Mugge. The decision of the court was that the complainant has an exclusive privilege to furnish electric lights in the city of Tampa and vicinity, and is entitled to a writ of injunction restraining the defendant from furnishing any lights in said city. The defendant has entered his appeal to the Supreme Court.

Suit Against New York Electrical Construction Company.—In the General Term of the Superior Court a decision has been handed down dismissing the action brought by George A. Wilbur against the New York Electrical Construction Company for commissions which he alleges were due him for securing from the city authorities of Utica a contract to light that city by electricity. His suit is dismissed on the ground that he acted as a lobbyist and his contract is held to be void, as against public policy.

Plainfield, N. J.—The suit of John Chandler against the Plainfield Electric Light Company to recover the value of his $3,000 trotting horse Rambo, which was killed last June by coming into contact with one of the company's live wires, was settled yesterday by a compromise. The company claimed that the horse met its death by an act of Providence, and gave notice that it would contest the claim. Just before the case was called it is said that Mr. Chandler received nearly the amount of damages claimed and the case was dropped.

Philadelphia, Pa.—Elizabeth McCardle recently began a suit in the Common Pleas Court against the Penn Electric Company of New Jersey to recover $20,000 for the death of her husband, Jesse McCardle, who was employed as a laborer by the company in digging trenches for laying underground conduits. While at work in front of the building, No. 908 Sansom street, on Nov. 17, 1887, an explosion of gasoline took place, and McCardle was so badly burned that he died a few days later. Mrs. McCardle claims that the explosion occurred through the negligence on the part of the company in not providing proper safeguards.

PERSONALS.

Mr. Charles I. Alexander, superintendent of the Edison Electric Company of Lawrence, Mass., has resigned.

Herr S. A. Sache, director of the post and telegraph system of the German Empire, is a visitor in Boston on a tour of inspection.

Mr. S. A. Duncan, of Pittsburgh, Pa., had a novel Christmas tree for the young folks. The tree was illuminated with numerous miniature incandescent lamps.

Mr. C. A. Baldwin has been appointed manager of the New England office of THE ELECTRICAL WORLD, to succeed Mr. L. H. Hart, who is promoted to the home office in New York.

Mr. L. H. Hart, who has for some time been in charge of the New England office of THE ELECTRICAL WORLD, has been transferred to the business department of the New York office.

Mr. C. D. Nash, of Whitman, Mass., has resigned his position as treasurer of the Whitman Electric Light Company. He has satisfactorily filled this position since the organization of the company.

Mr. Robert Nesmith, superintendent of the Allegheny County Light Company, Pittsburgh, Pa., received a pleasant surprise on the 1st of January in the shape of a handsome gold watch and chain, the gift of his employés.

Mr. J. P. Wintringham, Vice-President of the Brooklyn, N. Y., Institute, Department of Electricity, at a meeting of the Department last week read an interesting paper entitled, "Some Introductory Notes on Electricity,"

Mr. John S. Sawyer, superintendent of the Electric Light Company, of Bennington, Vt., has resigned, and will be succeeded by Mr. E. E. Larrabee, of Bath, Me. Mr. Sawyer had also been manager of the Hoosac Falls plant.

Prof. E. J. Houston, of the Philadelphia Central High School, gave a lecture upon "Electricity" last week at the College of Pharmacy in that city at the time of the inauguration of the electric light plant in that institution.

Mr. P. Leahey, superintendent of the Middletown, Conn., Electric Light Company, has been offered a position with the East River Electric Light Company, of New York City. As Mr. Leahey has a contract until July 1, 1891, with the local company he will have to decline the offer, although it was a very liberal one.

Mr. E. R. Weeks, general manager of the Kansas City Electric Light Company gave his family a pleasant surprise on Christmas morning by suddenly turning the current on many small incandescent lamps arranged among the branches of the tree. This would be an ideal way of illuminating Christmas trees at all children's entertainments.

Mr. K. F. Flynn, of New York, who was for many years the superintendent of the Western division of the Baltimore & Ohio Railroad telegraph service at Newark, O., and recently manager of the Western Union service in the Produce Exchange at New York, has taken the position of manager of the Pittsburgh offices of the Western Union Telegraph Company, made vacant by the resignation of Mr. James W. Clark, who held the office for some years.

Mr. O. T. Crosby, formerly manager of the southern distric of the Edison General Electric Company with headquarters at New Orleans, has accepted the position of general manager of the railway department of the Thomson-Houston Electric Company with an office in Boston. This position was made vacant by the resignation of Capt. Eugene Griffin upon his election as second vice president of the Thomson-Houston Company. Mr. Chinnock succeeds Mr. Crosby at New Orleans.

Mr. S. A. Barton's resignation has caused a notable change in the directory of the Thomson-Houston Electric Company, Lynn, Mass. Mr. Barton was the organizer of the company and a member of the board since 1882. From 1882 to 1885 Mr. Barton also occupied the position of general manager and treasurer, at which time he removed to Chicago to build up a western business. On returning in the winter of 1889 he organized a central purchasing department for the various Thomson-Houstor interests, and has recently assented to taking the presidency of the Brush Electric Company at Cleveland, O., and reorganizing the same, but will not change his residence.

MISCELLANEOUS NOTES.

An American Exhibitor at the Frankfort Exposition.—The Beacon Vacuum Pump and Electrical Company, of Boston, Mass., has announced its intention of sending one of its vacuum pumps for exhausting incandescent lamps to the Frankfort Exposition in Germany next year.

The "Electrical Enterprise" is the name of the latest addition to electrical periodicals. It is published in Boston once a week and appears for the first time with the opening of the new year. It announces itself as "a weekly newspaper devoted to electricity and kindred interests." John G. Lynch is its editor, Frank M. Gilley its associate editor and Albert P. Bicknell its business manager.

Industrial and Trade Notes.

Messrs. Stillwell & Bierce, of Dayton, O., have 4,500 of their feed-water heaters in use.

The Electric Gas Lighting Company, of Boston, has issued a new edition of its catalogue and price-lists, which comprises a line of general electrical supplies.

The Gibson Storage Battery Company is in receipt of large orders, and the outlook for 1891 is very promising. The tests of its battery show remarkably fine results.

The Electrical Supply Company, of Chicago, has recently published a supplementary price list of its galvanized iron and steel wires and strands for various electrical work.

The Metropolitan Rubber Company is rushed with orders for its new "G. H. M." hard rubber tubing. Mr. G. H. Meaker of this company has just returned from an extended trip to the West and South.

Mr. P. L. Kasi Nath, electrician, Chirawa, via Sikar Rajputana, India, is desirous of securing the catalogues of American electrical manufacturers, and will appreciate any courtesies shown to him.

W. H. Gordon & Co. are meeting with great success in the sale of the Ellis oil filter for use in electric light and power stations. The Star electrix specialties and simplex wire are also having their usual extensive sales.

A Midsummer Night's Dream is the title of a most pleasing pamphlet published by Merchant & Co., importers and manufacturers of metals. This company makes a specialty of copper wire for electrical purposes.

The Wells Engine Company, of 91 Liberty street, this city, calls attention to its balanced compound and quadruple expansion engines, for which the company claims a great saving in power due to the "balance" principle.

The Washburn & Moen Manufacturing Company, of Worcester, Mass., has recently got out a little pamphlet of electrical memoranda which contains much useful data, besides reminding the public of the wire supply of this house.

The Standard Paint Company is kept busy filling orders for its armature varnish and "P. & B." insulating tape. The business of this company for the past year has been doubled in all the specialties handled by it for the electrical trade.

The Clement Manufacturing Company, of Northampton, Mass., manufactures the "Vulcan" insulated screwdriver, for which tool is claimed, aside from its perfect insulating quality, that it contains no oxidizable material, thus insuring against carbonization.

The Stewart Heater Company, of Buffalo, N. Y., manufactures an excellent feed-water heater which is being adopted by many electric light companies. One square foot of heating surface per horse power is claimed for this heater among other good points which the company guarantees.

The Phœnix Glass Company, always in the front with electrical novelties, has just introduced to the trade some very handsome designs in shades, bulbs and globes in cut glass. This company has now under way some other novelties which, when out, will surprise the trade and be an innovation in this line.

The Star Electrix Company, of Philadelphia, reports that although it has been overrun with orders for "electrix" switches and sockets, it is now getting into good shape again, and is ready to fill orders promptly. The company started with a large

stock, which was supposed to last six months, but the demand for the electrix goods exhausted the stock in 60 days.

The Hanson & Van Winkle Company, Newark, N. J., is composed of the same members of the old firm of Hanson, Van Winkle & Co., and succeeds to the latter's business. With an increase in capital, and with all the modern and improved machinery, the new company expects a large increase in business during the year, and is in a position to fill all orders promptly.

The Commercial Electric Company, of Detroit, Mich., has recently completed arrangements with the Edison General Electric Company for the exclusive sale of the Edison patented appliances in that city. The company has issued a very neat pamphlet, showing electrical supplies kept by it. The Fisher automatic incandescent dynamo is sold exclusively by the Commercial Electric Company.

Specialties in Metal.—The Consolidated Fruit Jar Company, of New Brunswick, N. J., is kept constantly busy manufacturing novelties as well as standard goods in metal for the various electrical supply and manufacturing companies. Owing to its extensive facilities, and the fact that all its machinery is of the latest design, the company is equipped to handle promptly large orders for any small device in metal.

The H. E. Swift Manufacturing Company, of Boston, is calling the attention of its patrons, and of the electrical trade gen erally, to its increased facilities for the manufacture of all classes of electrical goods, and to the fact that it is specially prepared to furnish estimates for incandescent lamp bases, wooden fuse boxes, adjusting balls, rosettes, bushings and extension plugs. Special attention will be given to experimental work.

The Massachusetts Electrical Engineering Company, of Boston, has recently got out a new test certificate, to be used for marking fuse wire. It is as follows:

Fuse Wire Test.

No.....
Advisable carrying Capacity..... .....Ampères
Fusing point in open air at 70° F. of a .... inch.....
piece attached to copper terminals.....Amp.

The John S. Noye Manufacturing Company, of Buffalo, N. Y., has recently installed quite a number of electric light plants with its engines, boilers, etc., among which have been the following: a 100 h. p. plant for the National Electric Manufacturing Company in Asheville, N. C.; a plant of two 18 × 24 engines for the city of Easton electric light station, of Easton, Pa., with three 150 h. p. boilers; a 100 h. p. plant at Clyde, N. Y., and one of its standard electric light engines in a plant of two Wenstrom dynamos for the Genesee Hotel, of Buffalo.

Messrs. W. R. Fleming & Co., 174 Fulton street, of this city, agents for the Harrisburg "Ide" and "Ideal" engines, have closed a contract during the past week for a complete 50 h. p. steam plant for North Plainfield, N. J. The "Ideal" self oiling engine is to be used and horizontal tubular boiler with patent furnace, Weitmeyer setting. They have also taken an order from the well-known firm of Ketcham & McDougal, of York and Washington streets, Brooklyn, for a 50 h. p "Ide" engine to run an electric light plant which is to be installed by this company.

The New York Belting and Packing Company has issued a circular with reference to a new trade mark recently adopted by the company. The managers say: "We have found it necessary to change the trade mark of our diamond grade of goods, and hereafter will use the double diamond brand, which we have secured, and after the disposal of goods bearing the old trade mark, all genuine 'diamond' grade of goods will bear the double diamond brand." The names "Fine Para" and "Carbon." used as brands by this company, will not be changed, however.

The Keystone Electric Company, of Erie, Pa., is now located in the new and commodious factory at the corner of Fourteenth and State streets, where it will manufacture the "Keystone" dynamos and motors of all capacities. The company also makes a specialty of an automatic motor for elevators and for blowing church organs. and carries a full line of general electrical supplies, besides doing considerable repair work. This company has a large number of local installations of the "Keystone" motor for light work, such as coffee mills, portable drills, ice cream freezers, printing establishments, etc. An elevator is soon to be put on the market by this company, which it is claimed can be controlled with great facility.

Gold Medal for Interior Conduits.—The recent demonstration and tests of the conduit system of wiring made by the Interior Conduit and Insulation Company, of New York, in Chicago, before the city authorities, electrical experts, insurance representatives, and later before the Illinois Chapter of Architects, were very elaborate in detail, and were the means of convincing all who were fortunate enough to be present of the superiority of the system. Prof. John P. Barrett, city electrician of Chicago, indorses the system as follows: "After careful examination I beg leave to say I thoroughly indorse the system of the Interior Conduit and Insulation Company for inside wiring. I further would state that the method of running the two branch wires in a single tube for incandescent electric wiring is approved by me, and I will cheerfully pass any electric installation that is equipped with this system, believing it to be the safest method of interior wiring yet devised. The appliances of the system are worked out in a manner which insures not only safety, but easy accessibility at all times." The Interior Conduit and Insulation Company has recently received a gold medal—First Award—at the Mechanics' Fair Association, of Boston, Mass., for its admirable system.

Queen & Co., Philadelphia, have just finished "taking stock," and are congratulating themselves that, in spite of the general dullness in business during the past three months, their sales have been greater than ever before, and the demand for their specialties is increasing month by month. Their standard resistance boxes, portable testing sets, ammeters and voltmeters, photometers, both portable and stationary, have been given careful consideration, and large orders are received from all parts of the United States and also for export. In addition to manufacturing a full line of instruments of the regular types, they are continually engaged in designing new apparatus to meet the wants of the electrical engineer. In this connection should be mentioned the new testing laboratory which Queen & Co. have added to their establishment. The room heretofore used for such purpose proving too small for the increasing work, a large isolated department has been built, which will contain everything necessary for first class work. Skilled workmen are employed, and the lathes and other tools are the best and most complete. Close attention is given to the making of apparatus for special work after designs or specifications furnished, or they will design instruments to fulfill special requirements. With Prof. Anthony as consulting electrician in addition to the competent corps at their headquarters, they are certainly well prepared to handle their large and increasing business.

Business Notices.

ST. LOUIS, July 22, 1890.

Shultz Belting Co:

GENTLEMEN: In reply to your inquiry as to the working of your patent pulley coverings, I take pleasure in stating that they do all you claim for them. We have very little, if any, slipping of belts, and can run with a slack belt; this means no hot journals. We have them on both of our Edison dynamos. Yours truly,

W. A. RUTLEDGE,
Engineer at the Mermod & Jaccard Building.

OUR ILLUSTRATED RECORD OF ELECTRICAL PATENTS

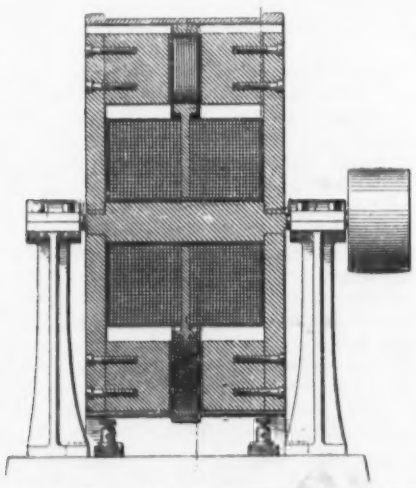
U. S. PATENTS ISSUED JAN. 6, 1891.

443,992. Manhole for Underground Electric Conduits; William H. Hart, of Brooklyn, N. Y. Application filed March 22, 1890. In a manhole of an underground conduit system, the combination with a base or floor of material impervious to gas and moisture, of double walls built upon said base, and having an interposed filling of composition impervious to gas and water beneath both walls.

444,005. Tightening Device for Suspended Electric Conductors; David Mason, of New York. Application filed May 28, 1890. A suspended electric conductor having a tightening device interposed therein for tightening or loosening the same.

444,006. Tightening Device for Suspended Electric Conductors; David Mason, of New York. Application filed May 28, 1890. A tightening device for suspended electric conductors, comprising two relatively adjustable members to which the conductor is attached, whereby the adjustment of said members may act to tighten the conductors.

444,067. Dynamo-Electric Machine; Alfred G. Holcombe, of Long Island City, Assignor of one-half to Charles L. Browne, of New York. Application filed Sept 17, 1890. The invention consists in mounting the armature or induced coils in a circular series in a fixed shell or ring-frame. The coils of the field-magnets are also secured to the fixed armature frame, while the pole-pieces revolve in bearings in definite relations to each other and to the armature coils. Each series of pole-pieces lies on opposite sides of the armature coils, one series being of one polarity



NO. 444,067.—DYNAMO-ELECTRIC MACHINE.

and the other of the opposite polarity, the field coils being divided into corresponding polarity.

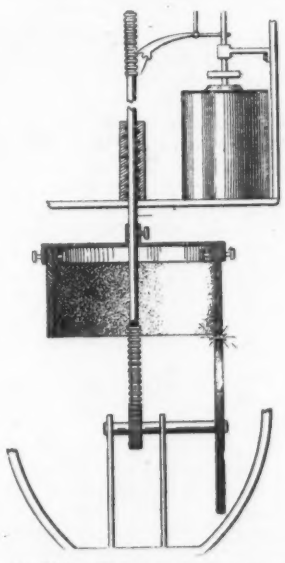
444,104. Electric Arc Lamp; Albert W. Reppy, of Oakland Pier, Cal. Application filed Sept. 27, 1890. In an arc lamp a combination of two rotary carbon discs having the pinions of unequal diameters, a stationary rack engaging the smaller pinion, and a rack carried by the carbon having the smaller pinion, said rack engaging the larger pinion, whereby the carbons rotate at unequal rates.

444,108. Signaling Apparatus; Isaiah H. Farnham, of Wellesley, Assignor to the New England Telephone and Telegraph Co., of Boston. Application filed Aug. 20, 1890. In an electrical signaling system, an electric circuit, an electromagnetic signal-bell or equivalent electromagnetic signaling device in a permanently closed branch of the said circuit, a signal-sending magneto-generator in a normally open branch of the said circuit, and means for increasing the resistance of the said bell-branch circuit, while the said generator is being operated to send outgoing signals.

444,110. Brake for Electric Cars; Belleville L. Randall, of Boston. Application filed Sept. 11, 1890. The combination, with a removable power rod, a rheostat, and its lever by which resistances are thrown in or out, of a revoluble brake rod and mechanism, as a chain, by which the rheostat lever is positively interconnected and operated separately by the power rod or by the brake rod.

444,144. Signal Box; John C. Wilson, of Boston, Assignor to the Municipal Signal Company, of Portland, Me. Application filed Jan. 14, 1890. In a signal box, a signal transmitter and a removable key or actuator by which the said signal transmitter is operated, and an answer-back bell and shunt therefor, combined with a switch operated by said removable key for opening the said shunt, thereby including the bell in circuit, rendering it responsive.

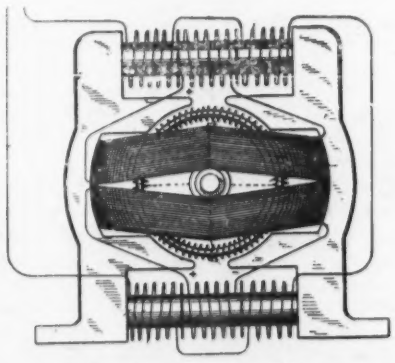
444,154. Electric Arc Lamp; Joseph J. Skinner, of Boston. Application filed April 27, 1886. The combination of a feed-controlling magnet and its armature with a clamp pivotally connected



NO. 444,104.—ELECTRIC ARC LAMP.

with the armature at one side of the carbon rod, and an independent lever connected at an intermediate point of its length with a fulcrum, and having one arm in position to be engaged by the armature of the feed-magnet and its other arm in position to engage with the free portion of the clamp, whereby the movement of the feed-magnet armature that carries one end of the clamp in one direction causes a movement of the lever that carries the opposite end of the clamp in the opposite direction.

444,188. Electric Motor; Charles J. Van Depoele, of Lynn, Mass. Application filed March 22, 1889. An electric motor comprising a closed-circuited armature having a coil in inductive relation thereto, a field magnet and a single external source of current therefor, and coils in secondary relation to the coils of the field magnet and connected to the induction-coil of the armature.



NO. 444,188.—ELECTRIC MOTOR.

444,223. Magnetic Ore Separator; Clarence Quintard Payne, of Stamford, Conn. Application filed Aug. 19, 1890. In a magnetic separator, two segmental ring-shaped pole-pieces placed concentrically, said pole-pieces being magnetized respectively by positive and negative polarity by means of one or more electromagnets, so as to constrain the lines of force to occupy positions approximately parallel throughout the magnetic field.

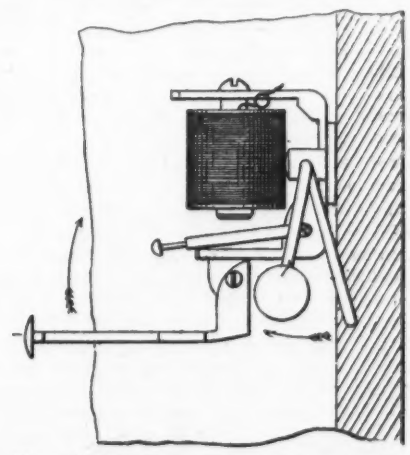
444,245. Electric Annunciator; August Hormel, of New York. Application filed July 29, 1890. In an electric annunciator, the combination of a C-shaped frame, with an electromagnet fastened to the upper shank, an armature pivoted to the back part, and an elbow-lever pivoted to the lower shank of said frame, the armature having a knob or hook on its free end which engages the elbow-lever by means of an aperture when the latter is in upright position.

444,265. Electric Agricultural System; Edward M. Bentley, of New York. Application filed May 11, 1888. The combination with a main supply-conductor extending along one side of a district, of a connection-conductor at an angle thereto, a third conductor having traveling connection with the first conductor, and an electrically-actuated machine having a traveling connection with the third conductor.

444,317. Electric Wire Insulating Cleat; John S. Potter of Newton, and David J. Cartwright, of Boston, Mass.; said Cartwright Assignor to said Potter. Application filed Aug. 16, 1890. An insulating wiring cleat for electric wires, having elevated or raised bearing surfaces on its upper side, and perforations passing through the cleat and such bearing surfaces for the reception of fastening screws for the purpose of clamping the cleat against such bearing surfaces only.

444,330. Support for Electric Lamps; James Chase, of Rochester, N. Y. Application filed May 17, 1890. The combination, with a pole or mast and the hood of electrical conductors having a pivotally mounted switch, by which the circuit may be either closed through the lamp or the latter cut out, and a staff having near one end a radial arm adapted to engage a hanger on the switch, said hood having an aperture in suitable proximity to the switch, and adapted to receive the end of the staff, and afford a bearing therefor.

444,374. Electric Switch; Charles Edwin Wilson, of Chicago, Ill. Application filed Sept. 13, 1890. The invention involves the combination with a base-plate having a recess therein and contact



NO. 444,245.—ELECTRIC ANNUNCIATOR.

plates, a spindle journaled in said base-plate at about the centre of said recess, a spring-arm secured to and projecting from said spindle and co-operating with the sides of said recess, a shifting frame and brushes to make and break the circuit.

444,377. Molding for Electric Wiring; George Cutter, of Chicago, Ill. Application filed July 21, 1890. A molding having a groove, and removable longitudinal partition-strips, of insulating material, placed and secured longitudinally in said groove.

444,392. Electrode for Secondary Batteries; Stanley C. G. Cutter, of Philadelphia, Assignor to the United Gas Improvement Company, of said place. Application filed June 10, 1890. A battery plate or element composed of the salts of a metal provided with an integral tough and compact supporting-rim of the same material but distinguished from the active portion of the plate or element.

444,397. Current Collecting Device for Electric Railways; Rudolph M. Hunter, of Philadelphia, Assignor to the Thomson-Houston Electric Company, of Connecticut. Application filed Sept. 24, 1890. In an electric railway, the combination of a conductor of magnetizable metal, a car, an electric motor to propel the car, an electromagnetic current-controlling device moving with the car and making a travelling connection with the conductor, the said electromagnetic device consisting of a magnetic core having guides for traveling along the conductor, and a magnetizing coil or coils surrounding the core and receiving current from the conductor.

Copies of the specifications and drawings complete of any patent mentioned in this record—or of any other patent issued since 1886—can be had for 25 cents. Give date and number of patent desired, and address The W. J. Johnston Co., Ltd., Times Building, N. Y.